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1896.

(BEING VOL. III.)

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CONTENTS.

(Mineral and Metallic Series, No. 5.)

THE AGRICULTURAL LEDGER.

1896—No. 1.

REH.

[*Dictionary of Economic Products, Vol. VI., Pt. I.,* R. 67-70.]

The DISTRIBUTION of the SALTS in ALKALI SOILS.

By E. W. HILGARD *and* R. H. LOUGHRIDGE.

As time progresses the importance of the alkali question, *i.e.*, of dealing successfully with the cultivation of lands more or less impregnated with soluble mineral salts, becomes more and more obvious. It is to be greatly regretted that the frequent mistaken efforts of land-owners to suppress, or at least to ignore, this matter for fear of injuring the selling value of their lands, interpose additional difficulties in dealing with an intrinsically sufficiently difficult problem. In view of this circumstance, we bear patiently the disappointment we have undergone in finding that, unexpectedly, one of our geographically most important culture experiment stations is almost wholly located upon ground subject to the difficulties inherent in the cultivation of alkali land; since we are thus enabled to study the problem independently of any private interests. Importance of the alkali question.

The culture experiment station near the town of Tulare, originally intended to represent the upper San Joaquin Valley at large, has thus, instead, become the station for the study of the alkali problem in all its phases, from the mildest to the worst. Until this problem is solved, no certain conclusions for the region at large can be drawn from the cultural results observed there; since we now know that all the vegetation on the Station grounds is under more or less stress from the alkali in the soil. If, however, we shall be successful in overcoming this influence, as we hope to be, the Station will have rendered, not only to the San Joaquin Valley and the State at large, but to the entire region west of the Rocky Mountains, a most important service.

Natural Condition of the Land.

For an understanding of the situation, it may be necessary to re-state here, that in their *natural condition* the lands of the Station, and for several miles around, as in hundreds of localities elsewhere in the valley and the State, show only occasional alkali spots; while outside of these spots, during the spring months, the country is covered with a Description of land.

REH. **The Distribution of the Salts**

luxuriant growth of native (largely annual) herbaceous plants, many being showy flowers and affording a most attractive sight; also proving beyond question the great inherent fertility of the land. As the season advances, from April to June, these plants go to seed or dry up, leaving the land more or less bare, or with only a sparse growth of hardy, drought-resisting, partially perennial plants. There is not, in ordinary seasons, any perceptible increase or decrease in the area of the interspersed alkali spots.

Behaviour without irrigation.

When such lard is put under cultivation *without* irrigation it will in years of unusual moisture bring very heavy crops of grain, which easily make up for at least *one* other season of almost total failure, when the rainfall is light or unfavourably distributed. It is this "fighting chance" of a highly remunerative crop that has in so many cases induced the investment of entire fortunes in such ventures, frequently with a total loss, and financial ruin as the result; a kind of agricultural gambling, little better in itself, and with as many chances against success, as that at the faro table, but now happily almost a thing of the past.

Behaviour under Irrigation.

Under irrigation.

With the advent of the irrigation ditch, the heavy grain crop becomes for a few years a matter of certainty. Then there is a gradual change for the worse. First it is noticed that the alkali spots increase their area outward, often merging neighbouring small spots into one large one. Then new ones begin to appear, at first "no larger than a man's hand," but enlarging each year, and finally often so cutting up and reducing the producing area, that the land is abandoned in disgust.

"Rise of alkali."

The "rise of the alkali" thus brought about by irrigation was very generally at first attributed (and sometimes justly) to the saline character of the irrigation water used. But as in time it became apparent that even the purest waters, such as those of Kings and Kaweah Rivers, would produce the same result, the conclusion that the alkali salts are simply brought up by evaporation from the soil itself, forced itself upon the most superficial observers.

The Question to be Solved.

Amount of salts contained in soil

Then arose the question, "How much of these salts does the soil contain, or where do they come from?" If it could be shown that the soil, subsoil, and substrata were equally impregnated with alkali, and would continue to supply indefinite amounts thereof. the reclamation of such lands for permanent cultivation would be almost hopeless.

Alkali salts contained in "bottom waters."

We at first approached the problem by the examination of "bottom waters" in cases where the latter had risen from a considerable depth in consequence of a filling-up from leaky ditches. It was found that in the vast majority of cases, such water contained relatively small amounts of alkali salts only; not more than many waters successfully used for irrigation elsewhere. It thus became evident that *the main mass of these salts exists in the soil and subsoil within a short distance of the surface.*

Position of salts in soil.

The chemical examination of the "alkali" moreover showed that it consists, as a rule, of such compounds as are known to be formed in *all* soils in consequence of weathering; and that it contains *all* the ingredients *useful*, as well as those *useless*, to plant growth; substances which, in rainy countries, are currently leached out and carried into the country drainage and finally into the ocean, but which in regions of scanty rainfall remain in the soil mass.

R, 67-70.

We are thus led to the vitally important conclusion *that the amount of the salts in these lands is but limited;* and that if once removed, or rendered innocuous to crops in some other way, it will take thousands of years in the future, as in the past, before another such accumulation can occur from the very gradual weathering of the soil mass.

In view of the extraordinary intrinsic and permanent fertility of alkali lands when once reclaimed, it has seemed desirable to study in detail the manner of the distribution of the soluble salts, as well as their kind at different depths in the soil and at different seasons; so as to gain an insight into their migrations and transformations, and thus to determine the best and cheapest methods of dealing with them. **Distribution of salts**

The problem is a very complex one and involves a great deal of labour, hence cannot be solved in one or a few seasons, because of the great diversity of soil conditions in different localities. The investigation has already, however, yielded such striking and practically important results that it seems best to bring them to public notice at once.

EXAMINATION OF SOIL PROFILES AND REPRESENTATION OF RESULTS.

The obvious mode of determining the points in question was to sample and examine the soil and subsoil at regular intervals of depth, in spots representing the land in its natural (unirrigated) condition on the one hand, and in the irrigated and cultivated on the other; tracing the effects of the latter condition so definitely as to be enabled to control, and repress them where desirable, at the proper times and by suitable means. **Results. Mode of procedure**

For more ready understanding the results thus obtained are platted so as to show by means of curves, or lines drawn from point to point of actual determination, the increase and decrease of the total soluble alkali as well as of the several salts composing it. As will be seen on the face of the plates below, the samples were taken (by means of a post-hole auger) so that each represented a vertical column of three inches of soil; continuing thus to the depth of two to four feet. Each of these samples was then leached of its salts, and every leaching analyzed separately. It was at first attempted to leach only the average of each foot, but this proved quite unsatisfactory.

In the diagrams the depths are shown by horizontal lines at intervals of three inches, as marked on the margin to the left; while the unbroken *vertical* lines represent differences of either two or four hundredths of one per cent. in the saline contents of the soil layers, as marked at the top of the diagram; increasing from left to right. **Explanation of diagram**

Inasmuch as each sample represented the average of three inches of soil in vertical depth, in drawing the connecting lines or curves the result of the analysis is assumed to represent the middle portion of each three inches. Hence, the changes of direction always appear as occurring in the middle, vertically, of a three-inch space. The area embraced between each curve and the vertical line to the extreme left represents, of course, the aggregate amount of each ingredient enumerated, *viz.*: Common salt, Glauber's salt, and sal soda as the chief ones, with Chile saltpetre (nitrate of soda), also mentioned on account of its fertilizing value, where present in notable amounts. The potash compounds, usually constituting from 3 to 7 per cent. of the salts, are not shown separately, being included in the "Alkali Sulphate" curve.

The predominance of carbonate of soda seen in these diagrams shows at once that the Tulare alkali is very "black," so that the use of gypsum to change the carbonate into sulphate is the first thing needful in attempt-

Explanation of Diagrams.

ing any reclamation or preventive measures. But aside from this, the diagrams suggest, very instructively, the explanation of many points not well understood heretofore.

Effect of the Rainfall.

RAINFALL. Depth to which salts may be washed.

It is well known to residents that in Tulare and northern Kern Counties the greatest depth to which the soil is wetted by the winter rains rarely exceeds three feet. This, then, is the depth to which the soluble salts in the soil may be washed each successive year by the natural rainfall; and from this depth it may partially or wholly reascend toward or to the surface by evaporation during each dry season. It is reasonable to expect that near the lower limit there will be a gradual accumulation of the saline matters, which reach it from above in the form of strong solutions.

Plate 1 illustrates this strikingly. It shows the condition of the natural, unirrigated land at a point half a mile north of the Experiment Station, which was at the time (May 3, 1895) covered by the native spring growth of herbage and flowers, and which during the dry season shows no sign of alkali on the surface. Evidently, at the time represented here the winter rains had washed the alkali salts so far from the surface down into the subsoil, that the seeds had no difficulty in germinating near the surface; and as the growing herbs covered the ground, practically *all* the evaporation took place through the roots and leaves, and hence the alkali did not move upward to any great extent. The bulk of the roots only reached to the level (18 to 24 inches), where the impregnation is not strong enough to hurt them. The soil moisture in this upper layer being pretty nearly exhausted by the evaporation *through the plants* during their growth, evaporation from the soil itself could not, thereafter, bring any perceptible amount of salts to the surface. Thus the first rain would, next season, again enable the seeds to germinate without injury from the alkali, despite the heavy impregnation farther down; which is seen, in this case, to be greatest about the second half of the third foot.

Evaporation of soil moisture.

Position in the soil of salt.

As a matter of course, not only the native growth, but also any *crop* of which a good stand has been obtained on an alkali soil, will similarly tend to diminish or prevent the rise of the alkali. Hence, a crop of alfalfa, once established, may flourish for years on ground that, so soon as it is left bare during the dry season for the fall sowing of a grain crop, may prove altogether too strong near the surface, and may kill the grain.

Influences of Crops.

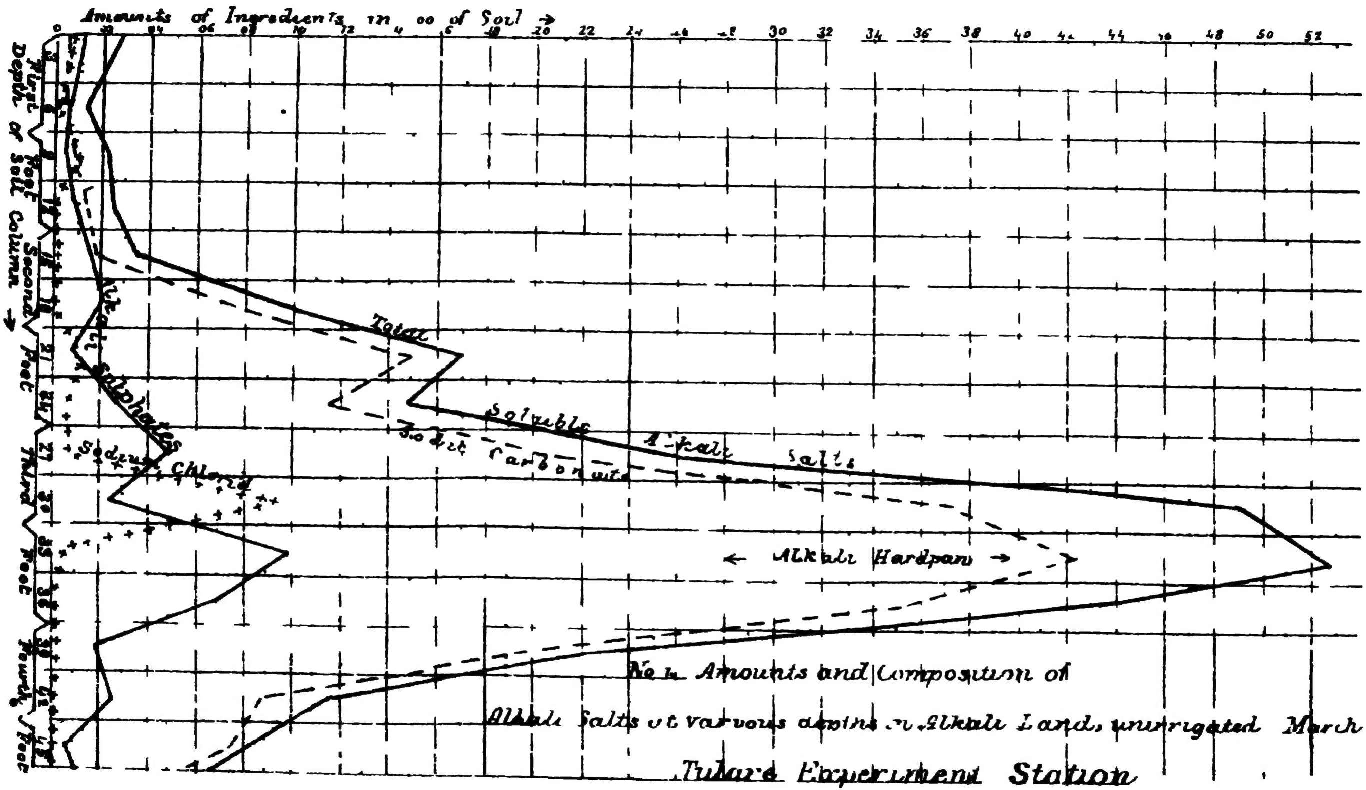
Decrease of salts.

From about the 35-inch level down we see a sudden and very rapid decrease of the salts, so that toward the end of the fourth foot they are reduced to little more than is shown at the end of the first foot from the surface.

Those familiar with "black alkali" lands in the upper San Joaquin Valley will at once recognize the three-foot depth as the one at which, in punching, or in digging post-holes or ditches, a very tough, intractable, clay hardpan is frequently encountered, which, when exposed to the air, soon becomes covered with abundance of white salts. This is the cause of the thick, loose layer of salts often seen alongside of irrigation ditches in the alkali regions.

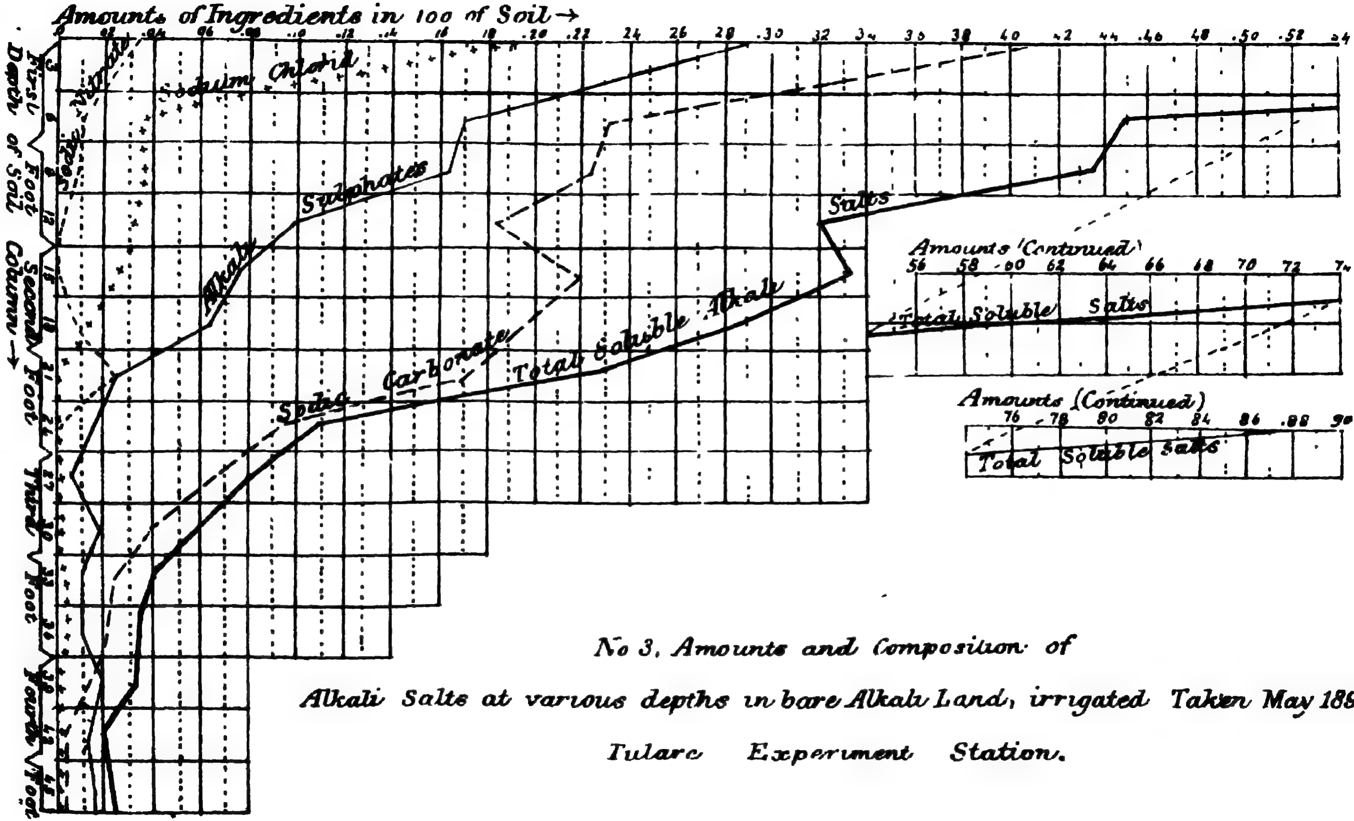
Bulk of Salts near surface.

We see thus demonstrated, beyond any possible cavil, the correctness of the conclusion we have previously drawn from the examination of the bottom waters, *viz.*: that *the bulk of the alkali salts is, even in natural alkali lands, accumulated within easy reach of the surface and of underdrains*; and that, *if this accumulation is once removed, no more, or at least*

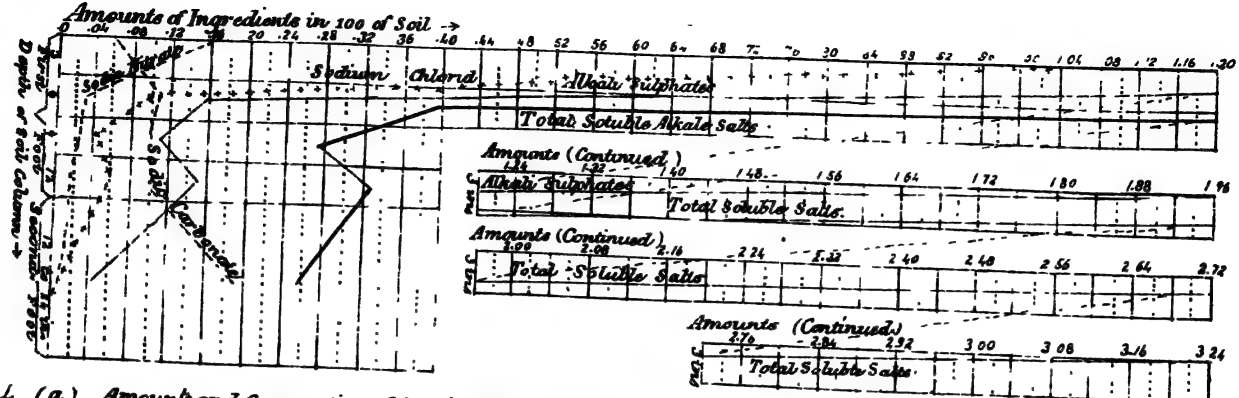


No. 1. Amounts and Composition of Alkali Salts at various depths in Alkali Land, unirrigated March 1895

Tulare Experiment Station

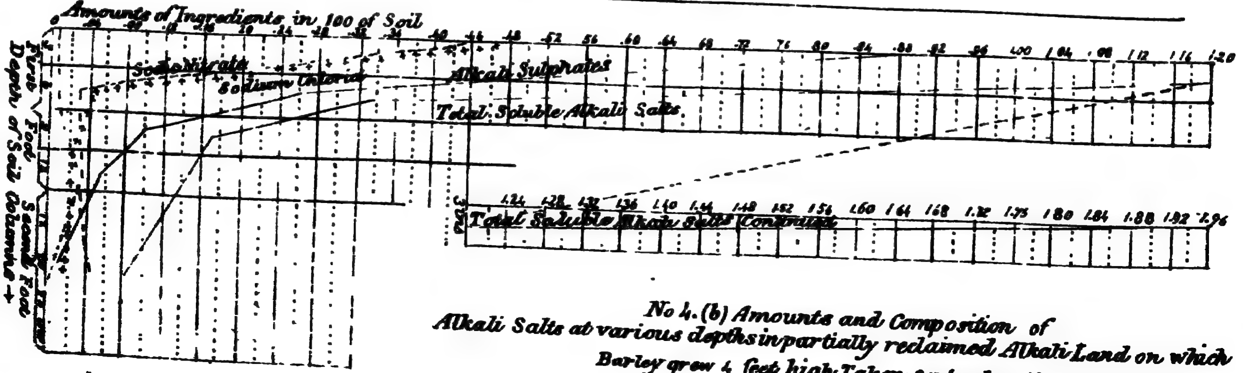


No 3. Amounts and Composition of Alkali Salts at various depths in bare Alkali Land, irrigated Taken May 1895. Tulare Experiment Station.



No 4 (a) Amounts and Composition of Alkali Salts at various depths in Alkali Soil on Which Barley Would not grow Taken Sept. 1894.

Tulare Experiment Station



No 4. (b) Amounts and Composition of Alkali Salts at various depths in partially reclaimed Alkali Land on which Barley grew 4 feet high Taken September 1894.

Under drainage.

not enough to do any harm, will come from below. This points to *underdrainage* as the ready and complete corrective of all alkali, as has been long ago recommended by us.

But it does not therefore follow that the indiscriminate use of underdrainage is to be recommended, since, as we have abundantly shown, enormous amounts of valuable soil ingredients would thus run to waste. In the majority of cases other means, presently to be referred to, will accomplish the reclamation.

Effects of Irrigation.

IRRIGATION, Effects of.

Let us now see what effect irrigation, or the establishment of leaky ditches in a pervious soil, will produce in land circumstanced as shown in Plate 1.

As regards the latter case, any one can see for himself that as the ditch water, filling up the land from below upward, comes in contact with the alkali-sodden subsoil or hardpan layer, it will dissolve the salts and carry them up toward the surface. Evaporation from the moistened surface will then go on all the year to a greater or less extent, and the alkali will keep steadily moving upward; until, in the course of a few years, the maximum will be found, not three feet below, but right *at* the surface. This is one phase of the "rise of the alkali," very easily understood in the light of Plate 1; and its outcome is graphically shown in Plate 3, which scarcely requires comment.

This diagram shows the condition of land originally similar to that represented by Plate 1, which has been irrigated for four or five years, and, quite lately, has also been influenced by a neighbouring leaky ditch, outside of the Station inclosure. Here we see that the alkali has moved bodily upward, and has accumulated near and at the surface to such a degree that any useful growth of ordinary crops has become impossible. Seeds sown (except those of salt bushes) are quickly corroded or "rotted" by such alkali as this, and fail to sprout; anything set out, ready-grown, may live while the rains last, but will be promptly killed by the corrosion of the root-crown, or lower end of the stem, from the effect of the strong solution formed around it whenever a light rain or heavy dew falls, even if the root should be able to resist the action of the alkali within the soil itself.

Why surface irrigation produces same result as rise of the bottom water.

It is not quite so easy to understand why surface irrigation should produce the same general result as the rise of the bottom water from below; and yet a little consideration readily explains it. Under irrigation the land receives many times more water than in its natural condition, but rarely enough to leach the alkali salts into the country drainage, even if the impervious hardpan layer did not stand in the way. Practically all this irrigation water therefore ultimately evaporates in the course of the year. As it penetrates the soil to a greater depth than the natural rainfall ever goes, it gradually dissolves the alkali salts in the subsoil, and in the progress of its evaporation throughout the season, carries them with it toward the surface, instead of leaving most of them accumulated at between two and three feet depth, as in the natural state. In the course of time, especially in orchards where the soil remains bare and therefore exposed to evaporation throughout the season, the accumulation near the surface becomes so great as to injure even the bark of full-grown trees and vines; while

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"Black" alkali or carbonate of soda.

Alkali ponds."

ordinary herbaceous vegetation becomes impossible. If the alkali should be of the "black" kind—*i e*, carbonate of soda—the soil will soon begin to settle, and puddles of inky water will remain for some time after rains or irrigation; sometimes forming permanent "alkali ponds," with a bottom of tough, impervious hardpan, of the same nature as that shown in Plate 1

That these worst effects can be suppressed by the conversion of "black" alkali into "white" by means of gypsum, has been already sufficiently explained in former publications The "white" or neutral alkali is many times less injurious than the "black," which is so corrosive that it dissolves not only the humus of the soil, but also the bark of plants, always excepting the wonderful "salt bushes" and their kind. But there are limits, varying for different plants, beyond which even the "white" alkali becomes incompatible with cultivation; so that its accumulation near the surface must always be prevented as much as possible Diagram No 3 shows the condition of bare irrigated land in May, at the end of the dry season, we find nearly the whole of the alkali concentrated within six inches of the surface, as is shown by diagrams Nos 4*a* and 4*b* These diagrams show strikingly that if we could afford to remove that first six inches of soil, we would have no more trouble from alkali, but at the same time, we would have seriously damaged the land's productiveness.

Effects of Cropping

Plate 2 shows the effect of a growing crop on the same land as that in Plate 3, within the Station grounds, the samples on the two plates having been taken within ten feet of each other But a heavy dressing of gypsum had been applied where 2*a* and 2*b* were taken, with good irrigation; and barley was sown in January 1895 Some rather abundant rains fell afterward, which naturally leached the alkali salts away from the surface, so as to leave it quite weak within the first foot. Evidently, the barley germinated and made its first growth under these conditions But as it failed to cover the ground fully, some surface evaporation took place and the alkali began an upward movement, the effect of which, in the increase of salts at the surface, is seen in both figures (2*a* and 2b), but modified, in the latter one, by the contrary effect of a light late rain, which diminished somewhat the salts at the surface. These two profiles are clearly the transition phase between the natural condition of the land as shown in Plate 1, and that of a bare alkali spot as exemplified in Plate 3; and illustrates well the effect produced upon evaporation, and the consequent movement of the alkali salts, even by a cereal crop, with its shallow roots and thin foliage. It is obvious that a crop of alfalfa, once established upon this land, and bringing to bear upon it the action of its deep roots and dense shade, would, by the repression of surface evaporation, tend to restore the natural condition as shown in Plate 1.

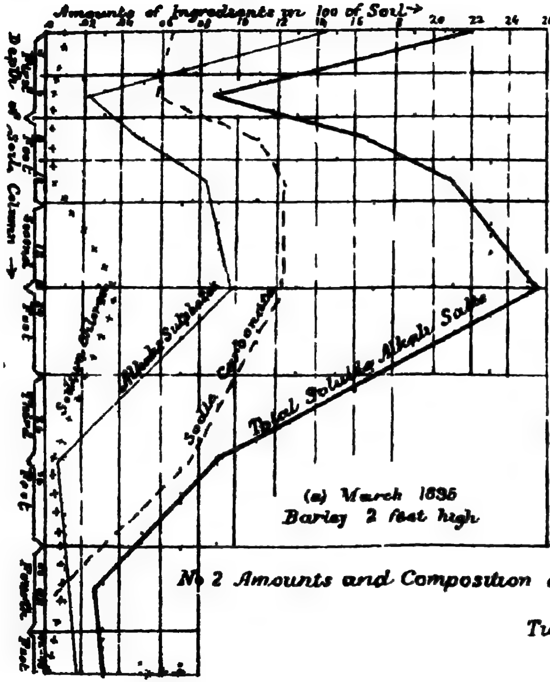
Alfalfa, beneficial agency of.

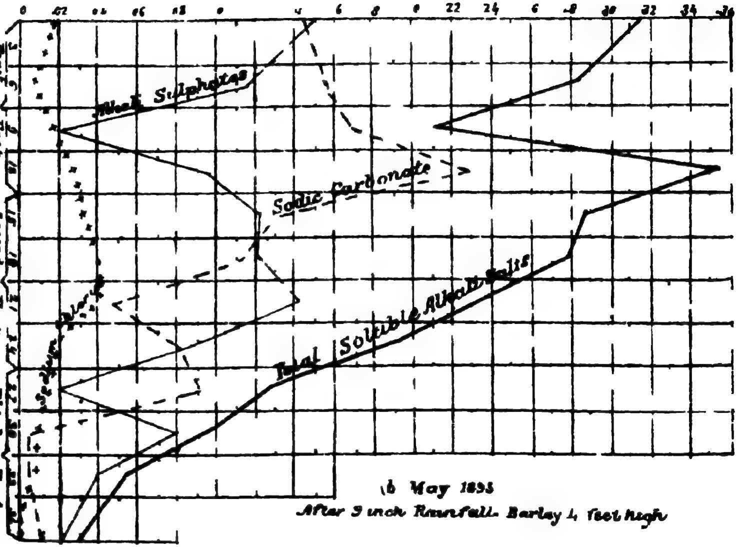
Counteracting Evaporation

PORATION.

From what has been said it is obvious that since *evaporation from the soil surface is the cause of any "rise of the alkali,"* one of the chief preventive measures must be *the reduction of surface evaporation to the lowest possible point* This can be done either by mulching or, less effectually, by shading.

R. 67-70.





No 2 Amounts and Composition of Alkali Salts at various depths in partly reclaimed Alkali Land

Tulare Experiment Station

The best mulch, available in all cases, is *a well and deeply tilled surface soil*, on which a crust is never allowed to form. Then evaporation will be reduced to the minimum, and whatever does take place leaves the alkali distributed through the whole of the tilled layer, instead of *at* the surface, where the bulk of the damage is usually done. For, a loosely tilled soil will take up little or no moisture from a denser or more compact subsoil, which it protects quite as effectually as would a straw mulch. **EVAPORATION.**

Of course, the depth or thickness of this protective tilled layer is of the utmost importance, not only for the sake of preventing evaporation and accumulation, but also because, since the maximum of alkali in irrigated land at the end of the dry season is always near the surface, the intermixing of the strong surface alkali with as large a mass of subsoil as possible, is important in order to dilute and diffuse it; so that it may not be strong enough anywhere to hurt the roots or root-crown. After such an intermixture, say to the depth of ten or twelve inches, it takes some time to bring the salts to the surface again to a sufficient extent to hurt the crop An instinctive recognition of this principle has led cultivators of alkali soils in some cases to resort to sanding the surface, and with temporary good results.

Important fact in the cultivation of alkali land.

But the mainstay in the cultivation of alkali land must always be *the maintenance of deep and loose tilth throughout the times when evaporation is active.* This implies the growing on them of hoed rather than grain crops, unless drill culture (which at present prices would hardly pay) were resorted to The growing of corn, beans, beets, and possibly of cañaigre, always choosing preferably the deep-rooted crops, is therefore indicated , and experience at Chino has conclusively shown that the very best of beets may be grown on light alkali soils in which common salt is not too prominent.

"Black" and "White" Alkali.

Use of gypsum on lands tainted with black alkali.

Deep and loose tillage, however, is practically impossible on lands tainted with any considerable amount of "*black*" alkali. It will remain cloddy, and will crust over even with dew, despite all cultivating, harrowing, and clod-crushing The first need, therefore, is *the neutralisation of the black alkali with gypsum*, by which operation other important benefits are also secured. The saving in cost of cultivation on heavier lands will alone soon pay for the purchase of the gypsum, aside from increased and improved products. It must always be remembered that little or no benefit is to be expected from gypsum in cases of purely "white," neutral alkali; but there are tens of thousands of acres of land now lying idle, lightly tainted with "black" alkali, that would be definitely reclaimed, and rendered profusely productive, by the use, once for all, of a ton of gypsum per acre. But it is not absolutely necessary to use the entire amount at once; it can also be done by annual instalments of, say, five hundred pounds per acre, put in some time before the seed. The latter will thus be protected from being killed by the black alkali, and secure a stand to shade the ground, preventing an injurious rise of salts for the season at least. It must be remembered, however, that *gypsum cannot act on alkali without water;* and that the action itself takes several weeks before immunity is secured, and continues for several months, and even longer.

When gypsum should be applied.

The dressing of gypsum should therefore be applied in ample time before seeding, and after cultivating or ploughing-in should be promptly

When gypsum should be applied

followed by irrigation, unless the rainy season can be relied upon to perform the service before seeding time. The smaller the seed to be sown the more important is this precaution, beans, peas, or maize may remain unharmed where alfalfa, or other clover seeds, as well as those of meadow and pasture grasses, would perish either before or during germination

One additional point should be emphasized here. It will be seen from the curve lines representing the individual salts—common and Glauber's salt, and sal soda—that the latter is proportionally most abundant in the clay hardpan (Plate 1), where it forms from 80 to over 90 per cent. of the whole; while near the surface, in the very same bore-hole, it forms about 23 per cent. only. This is due to the moisture and want of aeration in the subsoil, acting in a manner not easily explained in a popular way. But it may be taken for granted that whenever an alkali soil is subjected to the action of stagnant water, or of abundant moisture without aëration, the formation of black alkali will take place This is the reason why the latter is most commonly found in low, moist ground, and in close, heavy soils, while on the higher ground adjacent the white salts alone may prevail. The "swamping" of alkali lands is thus seen to be doubly pernicious, and the leaky ditches which cause it should, for this reason alone, be considered a public nuisance.

G. I. C. P. O. No. 89½ R. & A.—23-7-96.—2,100—H. R.

R. 67-70.

(Vegetable Product Series, No. 18.)

(Gums & Resins.)

THE

AGRICULTURAL LEDGER.

1896—No. 2.

ACACIA CATECHU.

CATECHU OR CUTCH, AND KATH.

[*Dictionary of Economic Products, Vol. I.*, A. 135-199.]

EXTRACT OF CUTCH PREPARED BY THE VACUUM PROCESS.

Result of Examination of a sample of Cutch received from MESSRS. MCARTHUR SCOTT & CO., *Glasgow, through* DR. WARTH, *together with commercial opinion obtained thereon, and introductory remarks by* THE EDITOR.

The following account of an analysis and commercial opinion obtained on a sample of Cutch of European manufacture is published for information as a Supplement to *The Agricultural Ledger* on Cutch, *No. 1 of 1895*.

The only explanation that can be given of the absence of agreement between the commercial report and the chemical analysis is that trade opinions are based mainly upon external appearances. The sample is unlike the ordinary article met with in the market, and probably bears resemblance to some inferior grade known to dealers. Hence the low comparative valuation of this sample. Such instances are by no means unknown. As a general rule the commercial expert is lost if carried out the field of comparative valuations. He knows little or nothing of chemistry. The practical effect of this is that the Glasgow article, unless made up in the manner of ordinary trade samples, may take a long time to find its way into trade.

An attempt to explain why the commercial valuation and scientific analysis do not agree.

ACACIA Catechu.

Extract of Cutch prepared by the Vacuum Process.

Note by Dr. Warth *on a sample of Cutch manufactured by* Messrs. McArthur Scott & Co., *154, Vincent, Street, Glasgow.*

The manufacture of Cutch has been dealt with in *The Agricultural Ledger No. 1 of 1895* by Dr. Watt. On page 12 will be noticed my suggestion that Cutch should be manufactured in India by the superior European method of extracting dyes from timber.

Sample of Cutch prepared by vacuum process.

A trial has now been made by the firm of Messrs. McArthur Scott & Co., who procured twenty tons (by measurement) of Acacia Catechu timber and shipped it to Scotland. The timber consisted of stems from 6 to 12 inches diameter, and it appeared to me when I saw it at Rangoon to be of average quality. This timber was treated by the firm with their vacuum apparatus, and the result is a Cutch of great purity and very good appearance. I have the honour to enclose a sample which the firm have been kind enough to send me. I have no doubt that the quality of this sample must also be very superior. It will probably be better even than any extract that could be produced on a small scale in a chemical laboratory. I may be able also to submit figures showing the percentage of yield of the timber by weight, but for the present it would be very interesting if a chemical analysis of this sample could be prepared, so as to compare with commercial Cutch from Burma and Bengal.

At the request of the Reporter on Economic Products, to whom the case was forwarded by the Inspector General of Forests for disposal, Dr. Leather, Agricultural Chemist to the Government of India, then furnished the following result of an analysis of the sample made by him :—

Chemical Analysis.

Analysis of Sample of Cutch.

	Per cent.
Crude Catechin	6·58
Catechu tannin	78·20

A sample of the Cutch in question was also submitted for favour of professional opinion to the Calcutta Chamber of Commerce, and in reply the Secretary wrote :—

Trade valuation.

"I am told that the sample of Cutch is very inferior to that imported from Rangoon, and the present rate of the two best known brands will be about R8 a maund. The sample you have sent is described as 'overboiled,' and valued at R3 per maund. It is said to be shipped to this market in two-ounce tins for mixing with paints, and in this form it has a special value, but for medicinal purposes, or for bazar use, that is for mixing with *pan*, it has no sale."

A. 135-199.

G. I. C. P. O.—309 R. & A. D.—27-8-96.—2100.—W. B. G.

(Veterinary Series, No. 18.)

THE AGRICULTURAL LEDGER.

1896—No. 3.

HORSES, ASSES AND MULES.

[*Dictionary of Economic Products, Vol. IV.*, H. 414-36.]

NOTES ON CHINESE MULES.

By VETERINARY CAPTAIN G. H. EVANS, A.V.D., *Superintendent, Civil Veterinary Department, Burma.*

Names. Transliteration.

In the following notes Chinese names are generally given and the corresponding Burmese name is sometimes entered in brackets. Vowels have their continental value. Distance between places is roughly indicated by the number of days' journey from one to the other.

There are two separate Mule-breeding areas.

Breeding in Shansisein.

1. In the jurisdiction of the Zon-du or Chief Commissionership of Shansisein about one month's journey north-west of Yi-nan-sein. Donkey stallions are here crossed with mares, which as well as the horses measure from 13 hands. They and the mules bred, which measure from 12 to 13 hands or more, are shorter in the back than the average Burman pony.

These mules fetch R300 to R500 and are used for riding by Chinese officials and merchants.

Authorities agree that they could without difficulty carry four ammunition boxes apiece (320lb). On account of the high prices they fetch, however, it does not pay to use them for transport, and they are never seen in Burma, and seldom in the Yinansein province.

Breeding in Yinansein.

2. The breeding of transport mules as used in Burma, is carried on in the division of the Sitao or Commissioner of Tali, who is directly subordinate to the Zon-du, Chief Commissioner of the Yinansein province.

Districts.

Immediately under this Sitao are, among others, the Fujwan or Deputy Commissioners, stationed at the following places :—

1. Talifu; 2. Lichangfu [eight days north of Tali]; 3. Tsu-shon-fu; 4. Yon-chan-fu (four days east-north-east of Tein-ye-cho or Momein). Mule-breeding is carried on in all the above districts, and most largely in No. 2. The following seats of Township officers in this area should also be mentioned as centres of the trade :—5. Sheu Dyen (Su equals O), one day south-west from No. 4 Yon-chan-fu; 6. Shäyän, two days east of Yön-chan-fu; 7. Yönpyin, two days east from Shäyän; 8. Yang-pyi,

MULE-BREEDING AREAS.

Localities from which mules for Burma are drawn.

four days east-north-east from Yōnpyin; and 9. Shāgwan, two days east from No. 4 Yangpyi.

The mules used in Burma come mainly from No. 5 Sheu Dyen township, some few from No. 6 Shayan township, and a fair number from the Yon-chan district No. 4. The proportion of Chinese owners to Panthès in this area is about five to one, the latter increase steadily in number as one goes from Momein to Yinansein.

Purpose for which employed.

The principal branches of trade for which these mules are employed, and their numbers stated very roughly, would be as follows:—

1.—Salt: Distributing from the Chinese Government Factory north of Tali-fu	5,000
2.—Tea: Distributing from Sze-mao, Puerh, Shan States round Kyinton, south of Tali, twenty days, and from Karen tracts still further south, and supplying markets as far east as Yinansein . . .	10,000
3.—Distributing Salt, Oil, Timber and miscellaneous produce, from that place to Yon-chan, Kaito, Yuyon (due east of Sadon) and other places . . .	2,000
4.—Salt, Cotton piece goods, and miscellaneous, to and from Manwaing and Namkhan and distributing thence in the Shan States	1,000
5.—Burma Government	2,000
6.—Miscellaneous internal Chinese trade	10,000
Total number available for work, say . . .	30,000

Working Season.

The working season extends from November to April inclusive, the rains being heavier in this part of China than in Burma and lasting about the same period. Arrangements for hiring are made in October, and the mules get back to their homes about May.

Owners or Kawtoks.

Kawtoks.

A single owner seldom owns more than fifty to a hundred mules. In China an owner of mules is called a Kawtok. The Burmans use this term or call them O-ok or mess president, because a managing Kawtok, as a rule, messes with the men under him.

Classification.

1. Those who go in for breeding and never accompany caravans.
2. Those who purchase mules.

The latter may be sub-divided, *viz.*, Managing Kawtoks who accompany their own mules, and others which may have been entrusted to them. Owning Kawtoks who hand their animals over to a manager for the working season and do not go with caravans. Lawbans are the middlemen between Kawtoks and hirers, the Chinese Lawban is a term applicable to any merchant or contractor on a large scale, and is also used by the Burmese. A Lawban will make necessary advances in China to Kawtoks at the beginning of the season and promise a certain monthly payment.

Settlement of disputes.

Disputes are settled by the arbitration of local magnates, and are seldom referred to Courts, which only open on certain days, and, as a rule, only adjudicate on cases of exceptional difficulty or importance.

Breeding.

Breeding.

The donkey mares are never crossed with pony stallions; they are kept to breed donkeys. The best donkey stallions are imported from Shansisin and fetch prices ranging to R300, they are stronger and

MULE-BREEDING.

larger than those bred in Yunnan, and cover mares without assistance. They cover annually from 40 to 50 mares, and are only employed for stud purposes between the ages of four and ten. The fee for covering private mares is R5. The breeding season is during April and May. In Yunnan the stallions receive assistance; some breeders after the mare is covered give her a kick in the abdomen giving the mare a shock, the idea being that she is more likely to hold, this corresponds to the practice at home of squirting a few mouthfuls of cold water into the ear.

Feeding.

Stallions receive a mixture of paddy and black beans, it is damped before being given, but is not allowed to soak. The mares and mules get a few pounds of paddy every evening. During the day the mares are sent out with one stallion to each batch, to graze under charge of a driver, they are driven in at night. If a stallion should cover a mare of another owner, the driver reports the matter and a fee is charged. No fences exist, except round cultivation.

Number of foals.

The number of foals obtained is usually twenty to thirty out of fifty mares covered. Pony mares are kept for further breeding. Colts with few exceptions are gelded and, when old enough, are used with the mules for transport purposes.

Breeders usually sell their stock at the third year. A mule is considered at his best between the ages of six and twelve; during this period they sell from R100 to R130, those over twelve hands fetch long prices. Mares are said to be stronger and sell for about R10 a head more than the geldings.

Attendants and their wages.

Drivers, etc.

About eight men are required to take charge of fifty animals, when at work thirteen or fourteen are wanted to look after the same number. These men are always provided by the owner, who engages extra hands for the open season.

Wages.

R4 for an inexperienced hand, to R15 for a man who understands shoeing and treatment of sick animals. Owners provide food, cheroots, etc., this amounts to about R7-8 per mensem in Burma, and about R3 less in China, if engaged for a long period they receive a suit of clothes every six months. The drivers usually settle when the season opens, and may receive their pay monthly from the managing Kawtok, or in a lump sum from the owner on their return home. Owners, as a rule, advance money to the Kawtoks for all expenses likely to be incurred. If it is found insufficient, he advances the money himself.

Adjustment of accounts.

On arriving home Kawtoks show their accounts, all advances made by either party are first refunded, the above expenses falling on the owner: allowance is then made for losses by death of mules, and the profit, if any, is equally divided between them. The average profits for a season run from R40 to R60, a good deal depending on the number of deaths.

Engagement of mules for Burma.

Kawtoks frequently visit trade centres like Bhamo, and take on contracts themselves without the intervention of a Lawban, rates as low as R17 to R19 are sometimes taken.

Treatment of Ailments.

Medicines.

Musk is a favorite remedy, a decoction is given in cases of colic, it is also used to inject into abscesses, and is used as a powerful astringent.

The Chinese have another way of treating colic, the sick animal is cast and secured, an incision with a knife something like a gum lancet is made in the centre line of the abdomen, just in front of the sheath, a trocar with holes through it is then worked into the abdominal cavity and allowed to remain for some time, if the patient appears easier he is allowed to rise, should he again show unfavourable symptoms the operation is repeated. The Kawtoks appreciate our method of treatment.

HORSES and MULES.

Notes on Chinese Mules.

MULE DRIVERS.

Use of Opium.

Use of Opium.

Most of the caravan people either smoke or eat opium, generally the former; they are, however, most careful to only take very small quantities. If they run short of the drug they are unable to undergo the fatigue consequent on long marching, and from changes of temperature and exposure, soon suffer from diarrhœa and dysentery, the drug seems necessary as a physical stimulant to keep the men in good health.

Acknowledgments.

The author wishes to record his thanks for the assistance and information he has received from the following officers: Captains G. P. Burrows, I.S.C., T. H. Davies, D.S.O., Devon Regiment, and Walker, D.C.L.I., Colonel Yule, Devon Regiment, and especially so to Mr. W. H. C. Minns, I.C.S., Assistant Commissioner, for having most kindly placed some valuable notes at his disposal.

G. I. C. P. O.—No. 1026 R. & A.—25-8-96.—2 100.—W. B. G.

H. 414—436.

(Medical and Chemical Series, No. 3.)

THE AGRICULTURAL LEDGER.

1896—No. 4.

ARTOCARPUS INTEGRIFOLIA.

(JACK-FRUIT TREE)

[*Dictionary of Economic Products, Vol. I., A.* 1489.]

THE CONSTITUENTS OF ARTOCARPUS INTEGRIFOLIA.—PART I.

Contribution from the Clothworkers' Research Laboratory, Dyeing Department, Yorkshire College, by ARTHUR GEORGE PERKIN, F.R.S.E., *and* FRANK COPE. *Reprinted from the Transactions of the Chemical Society, 1895.*

Artocarpus integrifolia is the well-known jack-fruit tree, belonging to the URTICACEÆ, a large tree cultivated throughout India, Burma, and Ceylon, except in the north. When freshly cut, the heart-wood is yellow, but this, on long exposure to air, gradually darkens, finally becoming of a mahogany colour. It is largely used for carpentry, furniture, etc., being considered one of the most handsome furniture woods used in the country, and is stated to be exported to Europe for this purpose. The rasped wood is used by the natives of India and Java as a yellow dye, in conjunction with alum, for colouring the robes of the Burmese priests, also for dyeing silk, and for general purposes.

Description. **Wood.** **Dye.**

A sample of this wood was brought to England by Mr. John Ingleby, late Chief Surveyor* of the Northern and North Central Provinces of Ceylon, who introduced it to the notice of Messrs. Wood and Bedford, of Leeds. This firm being anxious to test its utility as a dye-stuff, and, moreover, being struck by its resemblance to old fustic (**Morus tinctoria**), imported a considerable quantity from Ceylon, and to them our best thanks are due for a supply of material for the carrying out of this investigation.

Characteristic property of the dye.

A characteristic property of this dyewood, by which it may be distinguished from either old fustic or any other natural yellow dye-stuff that has come under our notice, is as follows. If an aqueous decoction be treated with dilute alkali, a yellow solution is obtained, and this, if gently

* Indian Civil Service.

warmed, assumes a beautiful blue tint, which, on standing, rapidly becomes green, and finally brown-yellow.

THE COLOURING MATTER. MORIN.

Description of experiment to extract the dye.

The ground wood was extracted for six hours with ten times its weight of boiling water, and the light brown extract, while still hot, treated with lead acetate solution as long as a precipitate was formed. After standing some hours, this was collected, washed with water, and the filtrate placed aside for subsequent examination. The lead compound, being made into a thin cream with water, was run in a fine stream into boiling dilute sulphuric acid, an orange-brown liquid resulting, which contained in suspension a small quantity of a sticky, resinous substance. As the latter had the effect of greatly retarding the subsequent filtration, the boiling mixture was treated with some quantity of barium chloride solution, the precipitated barium sulphate formed carrying down with it this impurity, which could now be readily removed by the use of a hot-water filter. The filtrate was extracted with a large volume of ether, the extract evaporated, the brown, semi-crystalline residue thus obtained dissolved in a little acetic acid, and the solution treated with three times its volume of boiling water. On cooling, a light-coloured crystalline product separated, and this was collected, washed with dilute acetic acid, and re-crystallised in a similar manner until colourless.

0·1254 dried at 160° gave 0·2740 CO_2 and 0·0394 H_2O. C = 59·59; H = 3·49.

$C_{15}H_{10}O_7$ requires C = 59·60; H = 3·31 per cent.

Thus obtained, it appeared as a mass of colourless, glistening needles, readily soluble in alcohol and acetic acid, somewhat sparingly in ether, and melting with decomposition at about 300°. Solutions of the alkalis dissolved it with a yellow colour, and if these liquids were treated with excess of alkali, crystalline salts were deposited in the form of slender needles. The barium and lead compounds were obtained as orange coloured, amorphous precipitates insoluble in water. Sulphuric acid dissolved the substance $C_{15}H_{10}O_7$ with a yellow colour, and addition of ferric chloride to its alcoholic solution caused the formation of a green liquid. It dyed mordanted calico with shades which appeared identical with those given by morin, one of the colouring matters of old fustic (**Morus tinctoria**), and as, moreover, both substances, when treated with sodium amalgam in alcoholic solution, yielded a characteristic deep green liquid, it appeared probable that they were identical. When heated they behaved similarly, and when destructively distilled both yielded a small quantity of a sublimate, crystallising from water in the form of minute yellow needles, which had the properties of Benedikt's paramorin (*Ber.*, 1875, 8, 606).

Calico dyed with artocarpus resembles that dyed with old fustic.

In a former communication (Perkin and Pate, this vol., 649) it was shown that though morin yielded acid compounds very similar to those produced from quercetin and other allied colouring matters, it differed from these in that during the formation of its sulphuric acid compound 1 mol. of water is eliminated. In order, therefore, to be quite certain that the colouring matter of jack-wood was really morin, its solution in boiling acetic acid was treated with sulphuric acid. On cooling, an orange-red, crystalline mass separated, which was collected, washed with acetic acid, and dried at 110°.

Further experiments described.

0·1382 gave 0·2388 CO_2 and 0·0400 H_2O. C = 47·12 ; H = 3·21.
$C_{15}H_8O_6,H_2SO_4$ requires C = 47·11 ; H = 2·62 per cent.

The hydrobromic acid compound, obtained in a similar manner, was also analysed.

0·1348 gave 0·2312 CO_2 and 0·0378 H_2O. C = 46·77 ; H = 3·12.
$C_{15}H_{10}O_7,HBr$ requires C = 47·00 ; H = 2·84 per cent.

The composition of the sulphuric acid compound, and a comparison of this and the hydrobromic acid derivative with those of morin obtained from old fustic, left no doubt as to their identity. The colouring matter of jack-wood is therefore *morin*. **Result of experiment.**

CYANOMACLURIN.

The aqueous filtrate from the lead compound of morin was treated with sulphuretted hydrogen, the lead sulphide filtered off, and the nearly colourless filtrate evaporated over the steam bath. During this operation, it became gradually darker, and, as a final result, a thick, sticky mass of a deep brown colour was obtained. Subsequently it was found preferable to discontinue the evaporation before complete dryness, for by this means the production of this dark-coloured product, the result of a decomposition, was partially avoided. To the liquid, a large quantity of common salt was now added, causing the precipitation of a sticky, brown product, which was removed by filtration through calico, and the resulting nearly colourless filtrate extracted with much ethylic acetate, and the extract evaporated. As the solution became concentrated, crystals separated out, a semi-solid, pasty mass being obtained on cooling ; this was thrown upon calico, squeezed to remove an adhering sticky substance, and finally strongly pressed. To purify this product, it was again dissolved in ethylic acetate, the solution evaporated to crystallisation, the residue mixed with some quantity of acetic acid, and filtered by means of the pump. By washing with small quantities of acetic acid, followed by chloroform, a colourless mass was obtained, which, if necessary, could be further purified in a similar manner. **Cyanomaclurin.**

0·1209 dried at 160° gave 0·2769 CO_2 and 0·0463 H_2O. C=62·46 ; H = 4·25.

0·1170 dried at 160° gave 0·2688 CO_2 and 0·0459 H_2O. C = 62·65 ; H = 4·35.

$C_{15}H_{16}O_7$ requires C = 62·79 ; H = 4·65 per cent.
$C_{15}H_{12}O_6$ „ C = 62·50 ; H = 4·16 „

It formed a colourless mass of minute prisms, which when heated commence to darken at 200°, and decompose rapidly at about 25°. Though it does not separate from its solutions in alcohol or acetic acid on cooling, it does not appear to be readily soluble in these liquids, prolonged boiling being frequently necessary to effect this object. From dilute acetic acid or water itself, however, it is deposited, after standing several days, in prisms closely resembling cane sugar in appearance. It does not dye with mordants. Sulphuric acid dissolves it, forming a beautiful, crimson solution, and with nitric acid a red-brown liquid is produced, which, on standing, gradually becomes of a scarlet tint. Ferric chloride colours its aqueous solution violet. With lead acetate, it yields no precipitate, but with basic lead acetate, a colourless, insoluble compound is formed. Most **Does not dye with mordants.**

Various dye colours obtained from cyanomaclurin.

characteristic is its reaction with dilute alkalis, for if but a trace be warmed with these liquids, a beautiful, deep indigo-blue solution rapidly forms, which, on longer digestion, passes into green, and finally brown-yellow. This, by neutralisation with acid, yielded no precipitate, and when extracted with ether and evaporated, a sticky, brown residue was obtained, from which at present we have been unable to isolate any crystalline product. On account of its above-described property, and as it stands to jack-wood in the place of the maclurin of old fustic, we propose for the name of this substance *cyanomaclurin.*

When an aqueous solution is boiled with dilute mineral acids, various substances appear to be formed, varying in property according to the length of the digestion, and resembling closely in appearance the so-called anhydrides of catechin (Etti, *Annalen*, 1877, 186, 332). The first product of this reaction separates out, on cooling, as a reddish-brown precipitate, sparingly soluble in water, and readily in dilute alkali, but as the digestion proceeds this is by degrees rendered more insoluble, there being finally obtained a red-brown powder insoluble in alkalis and solvents. As is well known, this reaction is characteristic of numerous tannin substances, and though cyanomaclurin is not a tannin matter, in that it does not coagulate albumin solution, it is evidently allied to catechin, maclurin, and other substances of this tannin class.

Cyanomaclurin allied to catechin and other substances of the tannin class.

It has been shown that various so-called "tannic acids," among others China—and chinovatannic acids (Rembold, *Annalen*, 1867, 143, 270) and filix-tannic acid (Malin, *ibid.*, 276), when digested with acid, are decomposed into an insoluble red substance and a sugar, being thus probably glucosides. Experiment showed that by this reaction no sugar was obtained from cyanomaclurin, and that the amount of final red product produced was equal to 85—90 per cent. of the weight of the original substance.

Alteration in colours the result of decomposition products.

The alteration in colour of the freshly cut wood from a yellow to a mahogany tint on long keeping, and the sticky, red-brown substances, obtained during the preparation of cyanomaclurin (p. 939), are evidently the result of the production of one or other of its above-described decomposition products.

Examination by Zeisel's method showed that it contained no methoxy groups.

Action of Fused Potash.

Action of Fused Potash.—In studying this decomposition, the substance was heated with 10 parts of potassium hydroxide and a little water, at 150—180°, for about three quarters of an hour. The dark-coloured solution at first formed rapidly became brown, gas being evolved, and the operation was discontinued when this had considerably moderated. The melt was dissolved in water, the solution acidified, extracted with ether, the extract evaporated, and the brown, sticky residue allowed to stand for some hours over sulphuric acid. Crystals were gradually deposited, and these were drained upon a porous tile, and purified by two or three crystallisations from water. The product consisted of nearly colourless needles melting at 208—209°, an aqueous solution of which, when treated with ferric chloride, gave a blue-violet coloration. Sufficient of this substance could not be obtained for analysis, but its reactions agree closely with those given for cresorcincarboxylic acid (methyldihydroxybenzoic acid) [$COOH : OH : OH : CH_3 = 1 : 2 : 4 : 5$], with which it is probably identical. The yield is exceedingly small, but we hope by

working with large quantities of cyanomaclurin to analyse the substance and confirm its identity.

In order to determine if this was the sole product of the reaction, a second experiment was made as follows. The residue from the ethereal extract of the melt was dissolved in water, and a sample treated with lead acetate solution; by this means only a minute amount of a dirty-coloured precipitate was obtained, too small to repay investigation.

To the main portion of the solution, barium carbonate was added to neutralise the acid previously shown to be present, the whole extracted with ether, and the extract evaporated. As the brown residue obtained showed no signs of crystallisation, it was digested for some hours with boiling toluene, and the solution treated with animal charcoal. Colourless, prismatic needles separated out on cooling, which were collected and recrystallised from toluene. This product melted at 103—104°, gave with lead acetate no precipitate, and with ferric chloride solution a faintly green coloration. Unfortunately the yield obtained was too small to allow of the certain identification of this substance, but in its properties it most nearly approaches those assigned to cresorcin (methyldihydroxybenzene; $CH_3 \cdot OH \cdot OH = 1:2:4$). For its investigation, considerable quantities of cyanomaclurin will be required, and as soon as this can be obtained, work in this direction will be continued.

Action of Diazobenzene.—From the results of the study of the reaction of diazobenzene with maclurin (C. S. Bedford and A. G. Perkin, this vol., p. 933), it seemed probable that the former might also combine with cyanomaclurin, and experiment soon proved this to be the case. An aqueous solution of cyanomaclurin, to which some potassium acetate had been added, was treated with a solution of about 2 mols. of diazobenzene sulphate, and the bright scarlet precipitate thus formed collected, washed with water, and dried. For purification, it was crystallised from alcohol, a hot solution of which deposits it somewhat slowly in spongy masses of needles. **Diazobenzene.**

0·1050 dried at 160° gave 0·2507 CO_2 and 0·0422 H_2O. C = 65·11; H = 4·46.

0·1199 dried at 160° gave 0·2863 CO_2 and 0·0486 H_2O. C = 65·12; H = 4·50.

0·1272 dried at 160° gave 12 c.c. of nitrogen at 20°, and 762 mm. N = 10·92.

$C_{15}H_{10}O_6(C_6H_5N_2)_2$ requires C = 65·32; H = 4·03; N = 11·29 per cent.
$C_{15}H_{14}O_7(C_6H_5N_2)_2$ „ C = 65·21; H = 4·34; N = 10·14 „

It was evidently a compound of 2 mols. of diazobenzene with cyanomaclurin. It forms a scarlet, glistening mass, somewhat sparingly soluble in alcohol, but very considerably more soluble in the usual solvents than the corresponding maclurin derivative. Dilute alkalis dissolve it with an orange-red colour, and these solutions, when treated with zinc dust, are reduced with the production of pale yellow liquids. It dyes unmordanted wool and silk, in a slightly acid bath, orange-yellow shades, very similar to those obtained with the maclurin compound, but, as was to be expected, it does not combine with mordants. **Action of alkalis on diazobenzene-cyanomaclurin compound.**

The analysis of cyanomaclurin agrees well, as shown above, with either of the two formulæ $C_{15}H_{12}O_6$ and $C_{15}H_{14}O_7$, whereas that of its diazobenzene compound, judging by the percentage of nitrogen, agrees somewhat more closely with the former, which is probably the correct **Result of analysis of cyanomaclurin.**

one. Both are interesting as they tend to show a connection with either morin, $C_{15}H_{10}O_7$, or catechin, $C_{15}H_{18}O_8$, and with both these substances it has points in common.

Further attempts to prepare acetyl, etc.

Attempts to prepare acetyl and other derivatives have yielded at present unsatisfactory results, and this is no doubt due to its instability in the presence of most reagents. It is our intention to continue the study of this most interesting substance, but this work will of necessity be slow, for its isolation from the dyewood in any quantity will entail considerable time and labour.

Tests to discover if maclurin exists in jack-wood.

As morin has been previously only known to exist in old fustic, and as this dye-stuff contains also a second colouring matter, maclurin, it was necessary to determine whether the latter also existed in jack-wood. Various tests, however, showed no indication of the presence of this substance; but in order to be quite certain, it seemed best to prove this indirectly by examining old fustic according to the methods employed with jack-wood.

Results.

A boiling aqueous extract of old fustic was therefore treated with lead acetate, the precipitate collected, and the filtrate, after removal of lead in the usual manner, evaporated to a small bulk. The dark-coloured liquid thus obtained was treated with excess of salt, filtered, the filtrate extracted with ethylic acetate, and the extract evaporated. The resulting sticky product showed no signs of crystallisation, and it was therefore dissolved in dilute acetic acid and allowed to stand some hours. A light yellow precipitate gradually separated, which was collected and purified by crystallisation in a similar manner, and this was found from its dyeing and other properties to be identical with maclurin. With lead acetate solution, it yielded a precipitate, but was not entirely thrown down in this way, and its isolation from old fustic in the above manner is due to the fact that its lead compound at first formed, is partially decomposed by the acetic acid which is simultaneously liberated from the lead acetate. On the other hand, morin is entirely precipitated by this reagent.

Morin the sole colouring matter of jack-wood.

Jack-wood thus treated as here shown yields no substance having the properties of maclurin, and its non-existence in this dye-stuff is thus conclusively proved. Morin is consequently the sole colouring matter of jack-wood, and the cyanomaclurin which it contains occupies the place of the maclurin in old fustic.

As the dilute acetic acid filtrate from the precipitated maclurin (see above) appeared to contain a second substance, it was evaporated to dryness, a dark-coloured sticky residue being thus obtained. When boiled with dilute alkalis, an aqueous solution of this product darkened somewhat in colour, but did not yield the characteristic blue tint formed when cyanomaclurin is thus treated. In a similar manner to the latter, however, it was decomposed by boiling dilute acids with formation of a red-brown precipitate, and evidently consisted of a substance not hitherto known to exist in old fustic. It gives no precipitate with lead acetate solution, and is therefore distinct from the tannic acid which, according to Löwe (*Fresenius Zeitschrift für Analytische Chemie*, 14, 127), is present in this dye-stuff in conjunction with morin and maclurin. This substance will be submitted to examination.

Dyeing Properties.

Properties of jack-wood dyes.

As was to be expected from the results of its chemical examination, jack-wood dyes shades very similar to those of old fustic, that is, olive-

yellow with chromium, dull yellow with aluminium, and a brighter yellow with tin mordant. The results obtained, however, are somewhat disappointing when it is considered that its sole colouring matter is morin, for this by itself dyes fine bright shades, whereas those yielded by the wood are duller in comparison. This must be accounted for as due to the brown decomposition products of cyanomaclurin which are probably formed to a slight extent during the dyeing operation, and also exist in the free state in the dye-stuff itself.

Medium results of trials with the dye.

Experiments showed that the sample of jack-wood here examined contained only about one-third of the colouring matter of old fustic. It is, however, probable that this represents a poor quality, for that brought originally from Ceylon by Mr. J. Ingleby was found equal to old fustic in dyeing power.

Opinion as to colouring properties of jack-wood.

G. I. C. P. O.—No. 1092 R. & A.—25 7-96.—2,100.—H. R.

A. 1489.

Correction.

Agricultural Ledger, 1894, No. 16. (Embankments in Agriculture.)

For Agricultural Series, No. 10,

read Agricultural Series, No. 9.

Agricultural Ledger, 1895, No. 23. (The Indian Churn.)

For Implements and Machinery Series, No. 3,

read Implements and Machinery Series, No. 2.

N.B.—Readers are requested to correct their copies by cutting out the lines enclosed by rules and gumming each one upon the line to be cancelled on cover and first page. Two sets of slips are supplied for this purpose.

(Vegetable Product Series, No. 19.)

THE AGRICULTURAL LEDGER.

1896—No. 5.

CAMPHOR.

[*Dictionary of Economic Products, Vol. II*, C. 257.]

CAMPHOR LEAF OIL.

1. *Note by* DAVID HOOPER, F.C.S., *Government Quinologist, Madras. Reprinted from the Pharmaceutical Journal of January 11th, 1896.*
2. *Introductory Note by* THE EDITOR.

INTRODUCTION.

The demand for a catch crop to be raised by Tea, Coffee and Indigo Planters is of so frequent recurrence that it may be of interest to republish a paper recently written by Mr. David Hooper of Madras on the subject of the Camphor Laurel Tree. The chief interest in Mr. Hooper's chemical investigations doubtless centres on the fact that he has shown that a fairly large supply of Camphor may be obtained from an oil distilled from the leaves. Hitherto it has been supposed that in order that India might participate in the world's supply of Camphor, it was necessary to plant extensive avenues or forests and to leave the trees for 50 or 100 years before looking for any return. Obviously an enterprise on a large scale of that nature could alone be seriously entertained by Government, and little progress has accordingly been made, though it has been demonstrated that the plant can grow almost anywhere in India. The tree is an exceedingly elegant one and where avenues are required might with advantage be planted more frequently than has been the case hitherto. The magnitude of the Indian import traffic in Camphor should, however, in itself be sufficient inducement to justify the occupation of useless land by such trees even were half a century necessary before they could be expected to give any return. But if Mr. Hooper's discoveries be regarded as manifesting a possible new direction, returns might be looked for within so short a period as to give the Camphor Laurel Tree a position in the planting world it has not hitherto enjoyed.

Mr. Hooper, it will be seen, has been able to obtain Camphor in fairly large abundance from the oil distilled from the leaves.

It may be as well to here briefly indicate the botanical sources of the chief forms of Camphor met with in commerce in order to point out more clearly the particular plant to which reference is made in Mr. Hooper's paper. There are at least three plants known to afford camphor:

CHINESE.

1st.—CHINESE (FORMOSA) and JAPAN CAMPHOR.—This is obtained from **Cinnamomum Camphora**—the Camphor Laurel Tree.

It is the Common Camphor of modern commerce though not the article of historic fame. The tree is a very slow grower and for perhaps half a century would not very possibly attain greater dimensions than that of an elegant large bush.

The Japan Camphor is generally preferred to the Chinese as it is, as a rule, purer. It is prepared by boilling chips of the wood similar to the method pursued in India in the manufacture of Cutch. It comes into India in its crude state and a fairly large industry exists in refining it, chiefly at Bombay, Delhi, etc. The refiner sells the purified article at nearly the same price as he purchased it, the profit being made on its mechanical absorption and retention of a large amount of water.

BARUS.

2nd.—BARUS CAMPHOR (Bhimsaini Camphor) obtained from a tree found in Borneo and Sumatra, etc., namely, **Dryobalanops Camphora**. This belongs to the same family as the Indian *Sal* tree. It is a large and handsome tree. To obtain the camphor the trees are felled and cut up into small splinters and the crystals of the naturally formed camphor picked out from the tissue of the wood. The crystals are chiefly found in the interior of the stem often existing as concrete masses which occupy longitudinal cavities, more especially near the knots and swellings formed where branches issue from the stem. The old trees are generally the most productive and a good tree, it is said, will yield about 11lb. In searching for good trees the natives are reported to pierce the trees to the heartwood, but it is stated, that, if left for seven or eight years after having been pierced, they may then be found to yield a good supply. Only about one-tenth of the trees thus ruthlessly destroyed are remunerative.

Conf. with the Agricultural Ledger, No. 1 of 1896, p. 6.

This is the Camphor of the ancient writers, and naturally from the small amount obtained and the labour that has to be expended on its collection it is very much more expensive than the "Common" or "Chinese Camphor."

NAGAI.

3rd—NGAI CAMPHOR of BURMA and CHINA.—This is obtained from a species of **Blumea** and is manufactured very largely at Canton. The plant is a herbaceous or bushy member of the family of the COMPOSITÆ. It seems probable that several species are employed, that most commonly being **Blumea balsamifera**—a species frequent in various parts of India as, for example, on the Eastern Himálaya between altitudes of 1,000 and 4,000 feet; on the Khasia hills, in Chittagong; Pegu and Tenasserim to China.

Ngai Camphor is chemically more nearly allied to Barus than to "China Camphor," and it is in point of price intermediate between

these two forms. Good Barus Camphor may fetch R80 a lb, whereas the Common Camphor is little more than half that sum per cwt.

Note by DAVID HOOPER, *Government Quinologist, Madras.*

WORLD'S SUPPLY.

The recent high price of camphor, on account of the war between China and Japan and trade monopolies, has caused some anxiety in countries where it is largely consumed, and China and Japan being at present the only two countries where camphor is produced on a large scale, it has been thought desirable that its cultivation should be taken up in other lands. In Japan the camphor trees grow at high elevations away from the sea, and only large trees of about one hundred years old are selected for use in making the camphor. From the export returns of this country, it seems that the supply is gradually becoming exhausted. In the island of Formosa the camphor trees are said to be by no means plentiful, and they grow only in certain favourable situations, as far as the climate is concerned, with savage tribes in the immediate vicinity. Here the trees are not considered worth taking until they are fifty years old, and the wood only of the roots and stems is subjected to distillation.

Japan.

Formosa.

India.

The camphor tree grows very well in India. The Calcutta Botanic Gardens possess a fine avenue of trees, which were introduced in 1802. It grows well in the Ootacamund Botanical Gardens and in other parts of the Nilgiris. It has been planted, as an experimental measure, at Jhansi in the North-Western Provinces, and in other districts in the plains.

Antiquity of the Camphor industry.

Camphor has been known and used in India for many centuries. In A.D. 642, Indian princes sent camphor as a tribute or offering to the Chinese emperors. At one time the tree flourished in Nepal and Tipperah, a large tract of land lying between Bengal and the Upper Irrawaddy. Within the present century camphor was imported from Chittagong, but it has been said that the discovery of the hill-men of distilling it from the root led to the extinction of the trees.

CEYLON.

In Ceylon the camphor tree grows well at elevations of 5,000 feet and less; it has the habit of a willow in the island, and it has been suggested that like a willow, the trees should be coppiced, and the leaves and branches used for preparing the oil. The tree grows for ornamental purposes in Naples and other parts of Italy. Professor Maisch in 1891 reported on the cultivation of camphor in Florida, where it flourished in almost any soil. The solid oil was made from the leaves and branches; the yield was 4 per cent., and the product was more like that of Japan, as it had an odour of safrol. California has lately become the scene of an industry which has for its objects the planting of the laurel camphor and the preparation of the oil for the American market. The tree has also become naturalised in Java, Brazil, Jamaica, and other isles of the West Indies, Mauritius, and Madeira.

ITALY.

America.

Slow growth of the tree.

It is very evident that the camphor tree is able to grow very luxuriantly and extensively in the warmer temperate and tropical parts of the world, far removed from China and Japan, but the slow growth of the tree would prevent all but large capitalists from opening up plantations and waiting for the plants to sufficiently mature. If it is true that in the island of Formosa the wood only of the larger trees is used, and the leaves and branches rejected, then there can hardly be a scarcity of the trees, or the manufacture must be conducted in a very reckless and extravagant manner. The camphor from the Dryobalanops tree is said to be quite liquid, if a young tree is tapped, and solid if the tree is old. Under such circumstances it would seem that the liquid oil constituted the first stage in the development of the solid substance. It is stated in some text-books on

materia medica that the *stearopten* exists in every part of the plant including the leaves. On the other hand, it is remarkable that the leaves are not used in China and Japan; perhaps the natives have found that the leaves only give a liquid product which cannot be profitably turned into camphor. As there is no definite information on this point to be found in any description of the industry, I thought it would be interesting to try the effect of distilling the leaves. Another reason that encouraged me to make some experiments in this direction was the hearty manner in which some energetic planters of Ceylon have taken up the camphor question.

CAMPHOR from LEAVES.

Oil.

A large number of experiments have been made, and a great deal has been written, with regard to camphor oil, the bye-product obtained in refining crude camphor before it is formed into blocks. This has been proved to be a very variable liquid with a specific gravity ranging from 0·88 to 1·00, an erratic optical rotation, although usually to the right and containing camphor in suspension, or in solution, or none at all.

Result of experiments with leaves.

The first sample of leaves came from an umbrageous tree growing in the Government Gardens at Ootacamund. Fifty pounds of the leaves in a fresh state were distilled in a large copper still with sufficient water for six hours. Eight fluid ounces of oil were separated from the distillate, giving the yield of essential oil one per cent. The oil had a slightly yellow colour, a specific gravity at 15° C. of 0·9322, and a rotation of +9°·4 in a 2 decimetre tube. It gave off a small quantity of liquid at 160°, and began to boil regularly at 175°.

Collected below 180°	=	20·6
185°	=	31·0
190°	=	15·5
195°	=	10·6
200°	=	5·6
205°	=	3·3
Residue	=	8·6
		95·2

The loss here was occasioned by some of the camphor congealing in the condenser; the amount, however, in this sample could only be about 10 or 15 per cent. The residue in the retort was quite solid in the cold, and had a yellowish colour and strong camphoraceous odour.

The second sample was obtained from some younger trees grown at Naduvatam on the Nilgiris, a district more than a thousand feet lower than Ootacamund. The leaves were distilled in the same manner as in the previous experiment, but a large quantity of camphor condensed during the process and almost choked up the worm of the still. About four ounces of liquid were collected, having a mass of crystalline matter suspended in it. The oil was strained through cloth, and the solid matter, pressed hard to remove all the liquid portion, was left as a cake of camphor, weighing two ounces. The clear oil had a specific gravity of 0·9314 at 15° C., and twisted a ray of polarised light +54° in a 2 decimetre tube. It began to boil regularly at 165°.

Collected below 185°	=	13·3
190°	=	20·0
195°	=	15·5
200°	=	20·0
Residue	=	25·0
		93·8

Result of experiments with leaves.

The loss was again accounted for by some of the camphor condensing in the cool tube. About one-half of this oil consisted of solid camphor, or calculating the camphor already separated, the oil from the Naduvatam leaves contained 75 per cent., which is a very satisfactory result. The camphor dissolved in rectified spirit, twisted a ray of light +30°. The altitude of the Government Gardens in Ootacamund is 7,300 feet, and it is possible that this elevation influences the formation of the solid *stearopten* in the leaves. At any rate, it is interesting to know that a large proportion of camphor can be obtained from the oil of the leaves and from the leaves themselves, and probably, if taken from trees grown at a much lower elevation, a much larger proportion of this useful substance could be collected.

G. I. C. P. O.—No. 1257 R. & A.—18-5-96.—2,100.—W. B. G.

(Vegetable Product Series, No. 20.)

THE

AGRICULTURAL LEDGER.

1896—No. 6.

ABROMA AUGUSTA, *Linn.*

[*Dictionary of Economic Products, Vol. I.,* A. 41.]

HIBISCUS ABELMOSCHUS, *Linn.*

[*Dictionary of Economic Products, Vol. IV.,* H. 168.]

MALACHRA CAPITATA, *Linn.*

[*Dictionary of Economic Products, Vol. V.,* M. 60.]

REPORT ON CERTAIN INDIAN FIBRES.

Result of Examination in the Research Department of the Imperial Institute, London.

Reason of present inquiries.

The following fibres from the Indian Collection of the Imperial Institute have been made the subject of chemical examination in the Research Laboratory. Their selection must not be taken as evidence that their merits have hitherto passed unnoticed; the reverse is indeed the case. Attention is now called to these fibres, because it is only by efforts concentrated upon a few out of many existing valuable materials, and by the continuous accumulation of evidence in their favour, that the natural conservatism of both growers and manufacturers can be overcome, and a fair opportunity given for the utilisation of these valuable natural products:—

FIBRES.	Moisture.	Ash.	Hydrolysis (*a*) Loss.	Hydrolysis (*b*) Loss.	Mercerising Loss.	Acid Purification Loss.	Nitration Gain.	Cellulose.	Length of ultimate fibre.
	per cent.	per cent	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	m. m.
MALVACEÆ.									
Hibiscus Abelmoschus (13 days steeping when in seed) . . .	11·	2·	11·3	13·4	16·7	1·2	39·4	77 7	2·5—3·

FIBRES.	Moisture.	Ash.	Hydrolysis (a) Loss.	Hydrolysis (b) Loss.	Mercerising Loss.	Acid Purification Loss.	Nitration Gain.	Cellulose.	Length of ultimate fibre.
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	m. m.
MALVACEÆ—*contd.*									
Hibiscus Abelmoschus (10 days steeping when in flower) . .	9·7	1·4	10·4	17·0	19·9	1·5	39·8	78·7	3·—4·5
Malachra capitata	12·5	1·	18·3	17·8	13·7	2·6	35·	74·2	4·—6^
STERCULIACEÆ.									
Abroma augusta (from new plant).	11·8	0·6	7·7	13·9	8·3	0·7	37·2	78·0	3·
Abroma augusta (from old plant).	9·4	0·6	11·4	16·6	13·7	2·4	42·2	·5	4·—6·4
Abroma augusta by Mr. Cross *"Report on Indian Fibres, page 9."* .	10·6	0·4	5·2	10·9	19·2	5·1	32·0	80·	...

The above are all of a high character, the colour being in each case good and the fibres free from reticulation and long in staple.

Hibiscus Abelmoschus.

Hibiscus Abelmoschus.—Length of staple 3—5 feet. The analytical figures for the two samples agree on the whole closely, but there is a noticeable difference of 4 per cent. between the corresponding higher hydrolysis-numbers. The sample taken "*when in seed*" appears to have undergone a slight amount of fermentation (shown by a faintly sour odour and by the poor condition of the fibre when examined under the microscope) and this would certainly tend to increase the hydrolysis-numbers. It is probable, therefore, that these are somewhat too high in the one sample, and consequently the difference between the two is slightly greater than appears to be the case. The natural conclusion is that this fibre, at the flowering season, is distinctly more susceptible to attack of hydrolytic agents, than it is later, during seed-time. The figures obtained give the fibre in question a high place amongst fibres of the jute type.

Satisfactory results of examination.

Malachra capitata superior to average jute fibre.

Malachra capitata.—Length of staple 6 feet. This analysis entirely supports the high opinion formed of the fibre obtained from this plant. The cultivation of jute, although quite successful in Bengal, is more or less a failure in Bombay, and it was hoped that this fibre would supply the place of jute in that Province. Unfortunately it has not made the headway expected of it, and Bombay is still dependent on Bengal for the sacking which is used in its grain trade. The Commercial Experts (*vide* Watt's Dictionary) have decided that the fibre of **Malachra capitata** is little, if at all, inferior to jute. Chemical and microscopical examination now show that it is superior to average samples of the latter fibre.

Good results from examination of Abroma augusta.

Abroma augusta.—Length of staple 4—8 feet. This member of the natural order STERCULIACEÆ was examined by Mr. Cross at the time of the Colonial and Indian Exhibition. The results he obtained are excellent, if too much importance is not attached to the mercerising figure, which, from the experience gained in the Institute Laboratory, seems abnormal. The two analyses now given, whilst they support the high character of the fibre, indicate at the same time the following distribution of advantages between new and old plants.

The fibre obtained from new plants has a larger percentage of cellulose and is less readily attacked by hydrolytic agents, but microscopically the ultimate fibres are somewhat thin and ill-formed.

In the older plants these fibres improve both in length and substance, but the percentage of available cellulose drops slightly; the fibre as a whole becomes harsher and coarser, and also suffers greater loss in weight from hydrolytic action.

The 17th January 1896. F. A. ABEL.

G. I. C. P. O.—No. 1317 R. & A.—15-6-96.—2,100.—W. B. G.

THE

AGRICULTURAL LEDGER.

1896—No. 7.

POLYGONUM CUSPIDATUM.

(THE ROOT.)

[*Dictionary of Economic Products, Vol. VI., Pt. I.*, P. 1090 a.]

SOME CONSTITUENTS OF THE ROOT OF POLYGONUM CUSPIDATUM.

Contribution from the Clothworkers' Research Laboratory, Dyeing Department, Yorkshire College. By A. G. PERKIN, F.R.S.E. *Reprinted from the Transactions of the Chemical Society, 1895.*

Among the different varieties of the species **Polygonum**, that best known is perhaps the **P. tinctorium**, the leaves of which are used as a source of indigo in China, Japan, and some parts of Russia. Of others, the **P. aviculare** and **barbatum** yield a blue colour, probably indigo, and the **P. Hydropiper** and **tortosum** are said to contain a yellow colouring matter; moreover, the roots of some of these varieties possess medicinal value.

The **P. cuspidatum**, which is common in parts of India, China, and Japan, has evidently attracted but little attention, the only reference found bearing on its properties being the following, contained in a paper (*Journal Royal China Branch of Royal Asiatic Society*, **22**, New Series, No. 5, 1887), by A. Henry, M.A., L.R.C.P., entitled "Chinese Names of Plants," "*Kan-yen, wu-tsu*, name at Patung for the root of **P. cuspidatum** which is said to be used for dyeing yellow."

Origin of the examination.

During the removal of some of this plant from my garden, my attention was directed to the root on account of its strong colour internally and its somewhat close resemblance to madder and morinda root. As much as could be obtained was therefore collected for examination, and for a further quantity I am indebted to Mr. Richard Reynolds, F.I.C., of Leeds, by whom the plant was originally introduced into this district. The roots vary in diameter from ¼ inch to 1 inch when fresh, and consist of a thick succulent bark, internally of an orange-red colour, and a central light yellow, woody portion; the former, on drying, shrivels considerably and becomes lighter in tint. As examination showed that the woody portion contained but little extractive matter, the bark only was preserved, and of this in the dry condition 600 grams was obtained.

Experimental Part.

The Glucoside Polygonin.

The ground root bark was extracted twice with 10 times its weight of boiling alcohol for six hours, and the resulting orange-brown extracts evaporated to a small bulk. The residual liquid, from which nothing separated out on standing, was treated with water and extracted with ether, the ethereal solution being placed aside for subsequent examination. The addition of baryta water to the aqueous liquid produced a dirty white precipitate, which was removed by filtration, and washed with water until the washings were nearly colourless. The deep red filtrate, after being neutralised with acetic acid and saturated with common salt, was extracted with a large volume of ethylic acetate, and the extract evaporated; as the solution became concentrated, a brown gelatinous precipitate commenced to separate, and a further quantity was deposited on cooling. This product, which appeared under the microscope as a mixture of gelatinous and crystalline matter, was collected, rinsed with ethylic acetate, pressed, and dissolved in boiling alcohol, it being necessary, however, to previously grind the mass into a thin cream with the solvent, otherwise complete solution could only be obtained by protracted digestion. On evaporating to a small bulk and cooling, the liquid deposited a gelatinous matter; directly this ceased to form, it was rapidly filtered, and the crystalline substance which separated from the filtrate was collected and purified by crystallisation from acetic acid. The gelatinous portion, when dissolved in boiling alcohol and treated in the manner above described, yielded more of the crystalline matter, the operation being repeated until at length crystals could no longer be obtained from the gelatinous matter which separated; the latter was then placed aside for subsequent examination. Analyses of distinct preparations of the crystalline substance gave the following numbers:—

0·1151 gave 0·2460 CO_2 and 0·0510 H_2O. C = 58·28; H = 4·92.
0·1091 „ 0·2340 „ „ 0·0495 „ C = 58·48; H = 5·04.
0·1095 „ 0·2325 „ „ 0·0495 „ C = 57·90; H = 5·02.
$C_{21}H_{20}O_{10}$ requires C = 58·33; H = 4·63 per cent.

It consisted of a glistening mass of orange-yellow needles, which, when heated, softened at 200° and melted at 202—203°. From its solution in boiling alcohol, in which it is but sparingly soluble, it is deposited in a gelatinous condition if rapidly cooled, but when left to cool slowly it separates as a bulky mass of hair-like needles. Boiling water and ethylic acetate dissolve it sparingly, and it is almost insoluble in ether. With cold dilute alkalis or baryta water, it yields orange-red liquids and by treating a boiling alcoholic solution of the substance with alcoholic potash, the potassium derivative separates, on cooling, in the form of red, flat, microscopic needles. The lead salt, an orange-red amorphous powder somewhat soluble in boiling water, is formed when lead acetate is added to an alcoholic solution of the substance.

Emodin.

Experiment soon revealed the fact that the above-described substance was a glucoside, and, in order to determine its nature, its solution in 60 per cent. alcohol was digested at the boiling heat with a small quantity of hydrochloric acid. During this operation, the light yellow liquid quickly became orange-red, and crystals separated; when the action had ended,

boiling water was added a little at a time, and the mixture allowed to cool. The product was collected, washed with water, and dried at 120°.

0·1224 gave 0·2980 CO_2 and 0·0450 H_2O. C = 66·39; H = 4·08.
$C_{15}H_{10}O_5$ requires C = 66·66; H = 3·70 per cent.

Thus obtained, it formed orange-red needles readily soluble in alcohol; it melted at 253—254°, and sublimed at higher temperatures with partial carbonisation. When distilled with zinc dust, a sublimate of greenish leaflets was produced, which, after crystallisation from alcohol, melted at 203°, and appeared to be identical with α-methylanthracene. Dilute alkalis and ammonia dissolved it with a red coloration, but it was almost insoluble in baryta water. The alkaline solutions when boiled with zinc dust became yellow, but on exposure to air regained their original tint. When it was dissolved in nitric acid (sp. gr. 1·54) and the solution evaporated to a small bulk and cooled, a semi-solid mass was obtained which crystallised from acetic acid in long, thin, orange-yellow needles. This product dissolved in solutions of the alkali hydroxides with a red coloration, decomposed with a slight explosion when strongly heated, and evidently consisted of a nitro-derivative. To convert the substance $C_{15}H_{10}O_5$ into its acetyl compound it was digested at the boiling temperature with a small quantity of acetic anhydride for three hours. On cooling, crystals separated, which, after recrystallisation from alcohol, formed lemon-yellow needles melting at 189°. Sufficient was not available for analysis. These results showed that the substance $C_{15}H_{10}O_5$ is *emodin*, a trihydroxy-α-methylanthraquinone, existing in rhubarb root (De la Rue and Muller, *J. Chem. Soc.*, 1857, 10, 298), and also in the bark of **Rhamnus frangula**, as a glucoside (*Trans.*, 1892, 6, 61, Thorpe and Miller). The acetyl-emodin melts at 190° (Liebermann, *Ann.*, 1876, 183, 161), and it has been previously shown (*Trans.*, 1894, 65, 934) that emodin reacts with nitric acid to form a nitro-derivative.

A determination of the amount of emodin produced by the hydrolysis of the glucoside gave the following result:—

0·3858 glucoside yielded 0·2385 emodin, or 61·82 per cent.

This result is in accordance with the following equation:—

$$C_{21}H_{20}O_{10} + H_2O = C_{15}H_{10}O_5 + C_6H_{12}O_6,$$

which requires 62·50 per cent. of emodin.

The filtrate from the emodin, after neutralisation with silver carbonate and evaporation, yielded an almost colourless syrup, but obviously in too small a quantity for purification. A solution of the substance reacted with phenylhydrazine acetate, on gently warming; lemon-yellow aggregates of an osazone being deposited on cooling. The examination of this glucose must be deferred until more raw material is forthcoming.

Frangulin, the only glucoside of emodin hitherto known, and found in **Rhamnus frangula**, is not identical with the above. When hydrolysed, for instance, it yields emodin and rhamnose ((Thorpe and Miller, *loc. cit.*),

$$C_{21}H_{20}O_9 + H_2O = C_{15}H_{10}O_5 + C_6H_{12}O_5,$$

a reaction which requires 64·9 per cent. of emodin, and its difference in composition ($C_{21}H_{20}O_9$ requires C = 60·57; H = 4·80), crystalline appearance, solubility, and other properties from the glucoside found in **Polygonum cuspidatum**, show clearly that they are distinct substances. I propose to give the name *polygonin* to this new glucoside of emodin from the **Polygonum cuspidatum.**

Emodin Monomethyl Ether.

The gelatinous residue obtained during the purification of the polygonin, had the properties of a glucoside, but as the quantity obtained did not exceed 0·1 gram, it could not be examined in this condition, but was at once hydrolysed by digestion with dilute hydrochloric acid, when a dirty orange-coloured crystalline product was obtained; this, by crystallisation from alcohol, was separated into emodin, which is readily soluble, and a second substance, characterised by its sparing solubility in this liquid. By recrystallisation the latter was obtained in yellow needles melting at 199°, though from more dilute solutions it was deposited in leaflets. It differs from emodin, also, in that it is insoluble in dilute ammonia, and almost so in alkalis of moderate strength. Its solution in sulphuric acid is also slightly bluer than the corresponding solution of emodin. While examining this substance, I was struck not only by the nearness of its melting point to that of emodin methyl ether (m. p. 200°) found in the root bark of the **Ventilago madraspatana** (Perkin and Hummel, *Trans.*, 1894, 65, 932), but also by the similarity of their appearance and properties. The quantity of substance available for experiment was only 0·05 gram, and, as the question of its identity could not be decided by analysis only, it was thought better to test its behaviour with sulphuric acid at 160°; for, in case it were the emodin methyl ether, it would thus yield emodin. The product of the action of sulphuric acid was accordingly treated with water, and the dirty, orange-coloured precipitate thus produced was collected and purified, first by crystallisation from dilute alcohol, and finally, from toluene. The orange-coloured needles thus obtained melted at 253—254°, dissolved readily in ammonia, and, without doubt, consisted of emodin. It therefore follows that the substance melting at 199°, obtained from **Polygonum cuspidatum**, is identical with the emodin monomethyl ether which exists in **Ventilago madraspatana.** In the former it is present in the condition of glucoside, but, as previously shown (*loc. cit*), it exists in the latter root in the free state.

It is interesting to note that Schwabe (*Arch. Pharm.*, 1888, 26, 569), and subsequently Thorpe and Miller (*Trans.*, 1892, 61, 6), isolated from the bark of **Rhamnus frangula** not only frangulin, but a second substance to which they respectively assigned the melting points 199°, and 202—203°, and this was considered by the latter authors to be probably a trihydroxymethylanthraquinone isomeric with emodin. The properties of this substance agree very closely with those of the emodin methyl ether above described, and it appears possible that they may be identical. Experiments will be instituted with **Rhamnus frangula** to decide this point.

The Wax.

The ethereal extract, obtained during the isolation of the glucoside, was extracted with dilute alkali, the red-coloured extract neutralised with acid, and the orange-red flocks thus formed were collected and purified by crystallisation from toluene; the product consisted of orange-coloured needles melting at 253—254°, and had all the properties of emodin. The quantity of emodin obtained from the root in the free state was exceedingly small.

As the remaining ethereal solution appeared to contain a wax, it was evaporated to dryness, and the colourless, sticky residue dissolved in a small quantity of boiling alcohol. On standing, the solution deposited warty nodules, and these were collected and purified by further crystallisation. The product consisted of beautiful, colourless leaflets which resembled phenanthrene in appearance, and melted at 134—135°. In

melting point* and properties it appeared identical with the wax existing in the root bark of the **Morinda umbellata** (Perkin and Hummel, *Trans.*, 1894, 65, 867), and, though the quantity obtained was very small (0·06 gram), it appeared evident that, if the two were identical, an analysis would yield numbers agreeing approximately with those formerly given (*loc. cit.*). This proved to be the case,

0·0536 gave 0·1635 CO_2 and 0·0560 H_2O. C = 83·19; H = 11·60.
$C_{18}H_{28}O$ requires C = 83·08; H = 10·75 per cent.

The wax contained in the root of the **Polygonum cuspidatum** is, therefore, identical with that existing in the root of **Morinda umbellata.**

The chief constituents of the root of **Polygonum cuspidatum** are thus shown to be a glucoside polygonin, $C_{21}H_{20}O_{10}$, which yields emodin on hydrolysis, also free emodin, an emodin monomethyl ether, and a wax $C_{18}H_{28}O$. In containing emodin, it shows a chemical connection with the rhubarb root, and with the bark of **Rhamnus frangula** in containing emodin methyl ether; also a connection with **Ventilago madraspatana** root and a similar relationship with the **Morinda umbellata,** in that they both contain identical waxes.

Dyeing experiments with the root, using mordanted calico, showed, as was to be expected from the chemical examination, that it was devoid of useful tinctorial properties; faint, dull shades were obtained, evidently due to the presence of a small quantity of tannin matter. It is thus evident that no yellow-colouring matter is present in this portion of the plant. Examination, however, showed that the *leaves* contain a small quantity of a substance which yields yellow shades with alumina mordant, and it is possible that some confusion has arisen between the leaves and the root with regard to this property.

It is my intention to study the constituents of the roots of the **Polygonum bistorta** and **Rumex nepalensis**—members of two closely-allied species.

* The melting point of this wax given in the former paper is 124—125°, an error which appears to have arisen during the correction of the proof sheets.

P. 1090 a.

G. I. C. P. O.—No. 1318 D. R. & A.—16-6-96.—2,100.—W. B. G.

(Special Veterinary Series, No. 1.)

THE AGRICULTURAL LEDGER.

1896—No. 8.

OXEN.

(CATTLE DISEASES.)

[*Dictionary of Economic Products, Vol. V.,* O. 551-594.]

SELECTIONS FROM THE REPORT OF THE INDIAN CATTLE PLAGUE COMMISSION, 1871.

By VETERINARY CAPTAIN H. T. PEASE, F.Z.S., *Assistant to the Inspector-General, Civil Veterinary Department.*

I.—INTRODUCTORY.

INTRODUCTORY.

The instructions originally communicated to us assigned the Provinces of Lower Bengal, the North-Western Provinces, and Oudh as a field of labour, and directed that the investigation should consist of a study of recorded outbreaks of cattle disease, and of local observation and inquiry in selected districts. The objects which were particularly to govern the conduct of the investigation and the drawing up of a report thereon were—

Objects of the Commission.

(1) to determine the nature of the diseases prevalent;
(2) the contagious character of these;
(3) their connection with, and analogy to, rinderpest; and
(4) the preventive and curative measures which might check the ravages of murrains among cattle.

Mode of inquiry.

2. These instructions and objects have been steadily held in view during the protracted and laborious inquiry which commenced on the 21st of December 1869 and terminated on the 31st of January 1871. It was realised at a very early stage of the proceedings, that, to study the question of prevention in an exhaustive manner, the conditions under which horned stock exist in India must be ascertained in detail, and that very numerous collateral questions bearing more or less directly on the question of prevention of disease must be made a subject of consideration. The whole scope of the investigation thus extended is summarily exhibited in the form printed at pages 82-84, which has served as a guide in eliciting oral

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testimony and a means of obtaining written information. As this form, which was most carefully considered at starting, embodies the whole spirit of the inquiry, it will be convenient also to adopt it as the groundwork of this general report.

Extension of sphere of inquiry. **The Panjab.** **Other provinces. Madras.** **Bombay, Central Provinces, Burma, and Andaman Islands. Ceylon.** **Cattle-poisoning.**

3. At first, the limitations imposed by the original instructions were carefully observed, but it was found that an expansion of both the field and subject of study would be attended with advantageous results. It became apparent, in the first place, that very serious events were occurring in the Panjab, involving the destruction of cattle by thousands, and, from the desciiptions of the murrains causing this havoc which were received, it was impossible to predicate their nature or advise as to their treatment. A local investigation in this province was accordingly suggested, and authority was readily obtained from the Government of India to extend operations thither. It was next found that important information was available from other provinces and parts of India, which might materially affect conclusions which it was sought to place on the widest possible basis. More particularly, the proceedings of the Madras Government in the matter of cattle murrains were fraught with peculiar interest and material instruction. Some reports had been received from places beyond the limits of the Bengal Presidency, and it was considered desirable to obtain a copy of all that had transpired elsewhere and initiate inquiry where none had been made. With this view a letter was addressed to Government moving for all the information which existed or could be got, and much valuable matter from Madras, Bombay, the Central Provinces, Burma, and the Andaman Islands was thus obtained. The present inquiry has thus become imperial in its scope, though the Bengal Presidency is necessarily more prominently and elaborately represented. Through the courtesy of the Colonial Government of Ceylon, the very admirable report, dated October 1869, of the Commission which had been appointed in March 1868 to investigate cattle plague was obtained and became another element in the subject-matter of consideration. Again, in some districts much of the mortality among cattle was attributed to the system of cattle-poisoning alleged to be perpetrated by dealers in hides, and it was considered necessary to work out this question in detail. A considerable body of evidence was procured, tending to place the facts of this question in a true and proper light.

Proceedings of the Commission.

4. While the objects of our Commission were those above indicated, the principles upon which the work has been carried on have been as follows:—

Local observation.

(1) local investigation and actual observation have been held as the most important means of arriving at accurate results;

Personal investigation.

(2) personal inquiry on the spot, in the locality where the events had occurred or were occurring, and from the persons best informed regarding, or most concerned in, the matter, was considered as second in importance; and

Written reports.

(3) when neither of these means were available, written reports were sought from the most skilled and competent persons likely to give the most reliable information.

Arrangement of the report. **According to locality.**

5. The result of these endeavours has been the accumulation from every part of India of a large mass of material of very various value. When the time arrived to arrange this material so as to place it in that shape in which it should be most useful for information and aid with regard to future action, the question of its arrangement became rather an embarrassing one. It was finally resolved, as the best of many possible alternatives, to pursue a strictly local principle of classifying and arrang-

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Importance of local observation.

ing the matter. This plan was adopted as the most simple and convenient, and likely to be the most useful, because, whatever action may in future be adopted in regard to this question, the details must vary according to local circumstances and requirements; and while the general facts and principles common to all places are set forth here, and the general indications of action may be embodied in one set of rules or one enactment, the application of such rules or enactment must depend upon and vary with, local conditions These, as far as they have been ascertained, are set down under each province, division, or district, and local inquiry anywhere may be carried on in continuation of, and with the light afforded by, the local data furnished in this report. Indeed, we contemplate as the perfection of possible energy in this matter strictly local investigation—guided and corrected by the facts generalised from many local inquiries, and strictly local action—directed and modified by principles founded on these general truths; and the more particular such inquiry and action become, the lower they descend—to townships, villages, hamlets, and households—it is obvious that the greater good will accrue in the end. We have thus striven, in the mode of our inquiry, in the construction of our report, and now in emphatic suggestion, to impress the futility of mere reports to a central and remote office or individual, and the necessity and efficacy of careful, continued, patient and practical local inquiry and effort. Our aim has been to render this report available for intelligent inquiry and action all over India, and to furnish as much general information and as many local data as may enable district officers or their subordinates to inquire and act to best advantage. Much yet remains to be known, and nearly all to be done.

Inquiry complete up to the end of 1870.

This report contains or refers to all that is known up to the end of 1870, and prescribes what ought to be done. There should be no necessity for again working out the subject generally as far as the past is concerned, but there remains the necessity of continuing the inquiry in every district of India, and these developments ought to be an expansion of the general, and in most cases imperfect, data contained in this record.

Need of further inquiry.

Local attention, investigation, and action, by one skilled agent or by a committee of persons locally interested, is the first and principal recommendation we have to offer, and we would very strongly urge that mere reporting is a very small part of what ought to be done, and that reporting prompt action adopted with success in staying mortality is the only sort of report which should in future be made. Catalogues of unintelligible names, the heterogeneous stringing together of hearsay symptoms and tabular exhibitions of unreliable figures, have hitherto represented, save in a few exceptional cases, the summit of energy. In future, names and symptoms should be reduced to the minimum, a few familiar names should represent well-known symptoms, and figures and tabular statements should exhibit work done, sickness and mortality reduced, and disease stayed by the prompt adoption of rational measures. These remarks have been made *in limine* under the conviction that, hitherto, there has been little or no practical observation attempted in this matter, and that the serious subject of cattle murrain has, in common with too many other matters, come to be treated in offices upon folios of foolscap, instead of in the village, the pasture field, the pen or the byre. Reporting, registering facts, comparing them, and drawing up general reports are of course necessary, and we trust that year by year, commencing with 1871, the progress of this important matter will be duly chronicled, but unless the local action is such as we have above indicated, reports, however careful, can never advance the question one single step, or contribute to the saving of one single life.

MURRAINS, CONDITIONS AFFECTING PREVALENCE OF.

II.—CONDITIONS AFFECTING THE PREVALENCE OF MURRAINS.

Topography.

6. Topography has been found to have an important bearing on the prevalence of murrain.

Insulation.

(*a*) If an absolute conclusion can be drawn from one example, the history of cattle plague in the Andaman Islands disproves the allegation of spontaneous origin, and proves that importation is the main, if not only, cause of outbreak of rinderpest and foot and mouth disease even in tropical malarious localities where endemic diseases are rife among men and even sheep. The lesson to be drawn from the experience of this settlement is, that if we would preserve the stock of an area free from disease, what the physical conditions of an island impose as regards outside stock must be imitated artificially—that is, localities must be, in respect of importation of disease, insulated.

Hills.

(*b*) Hills oppose another physical obstacle to cattle association, and provide for a certain amount of isolation of stock. We have accordingly found that, as far as our information of hills and hill stations permit a general statement, disease is not so frequently met with upon them, and, when it does occur, its importation is always traceable, and there is never any suspicion of spontaneous origin, as is often the case in the plains.

Rivers.

(*c*) Large rivers oppose a physical obstacle to the spread of murrain, and this should be taken advantage of in endeavouring to cope with them. The best illustration of this fact is the outbreak of disease in North Lakhimpur in March 1869, while it did not make its appearance in the portion of the Lakhimpur District south of the Baramputra till June 1869, and it was then derived from the South. The importance of guarding ferries, which are a means of rendering futile the protection which rivers afford, is obvious.

Grazing-grounds.

(*d*) The influence of luxuriant pasture tracts where cattle are herded and grazed, drawn from many points, mix together, and are then dispersed to their villages, in providing an abode and nursery of contagious diseases among stock, is frequently pointed out in the Appendix. The whole tract of the Himalaya Tarai, the Orissa Gurjats, the Rajmehal Hills illustrate the truth of the general assertion, and this widespread and necessary practice furnishes a kind and magnitude of conditions eminently calculated to maintain and spread contagious disease that it is difficult to meet by any general suggestion or rule. The problem of prevention and limitation must here be worked out locally, as, while the general practice and its tendencies and dangers are similar, there are local circumstances and variations which must govern the thought and action to be taken.

Roads.

(*e*) The influence of roads in spreading disease is well known and illustrated in the case of Ceylon, Darjeeling, etc.

Civilisation and clearing.

(*f*) Increasing civilisation, which means in India clearing of jungle, making of roads, extended agriculture, more communication with other parts, buying and selling, etc., provides greater facilities for the spread of contagious diseases of stock. This is illustrated in the case of Burma.

Influence of soil.

(*g*) Our observations have been mainly conducted on the plains and upon an alluvial formation, but nothing that appears in these papers tends in any respect to establish a relation between any kind of country and soil and murrain except in as far as variations of this sort modify the other life conditions of stock, namely, number, association, etc. In other words, there is no evidence to show that cattle disease may and does not prevail on any area, whatever its geology, soil, altitude, etc.

Disease not soil-born.

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These considerations go to establish the general statement that there is nothing in the geology or topography of India to render these diseases inevitable or irradicable, and place their causation on less difficult and insuperable conditions, thus giving a greater promise to repressive effort.

Geographical distribution of murrains.

(*h*) The geographical distribution of murrains may be appropriately considered here, and with regard to the two principal forms of them, rinderpest and foot and mouth disease, suffice it to say that, wherever observation or inquiry has reached, they have been found to prevail or to have recently prevailed. It is certain that the *reported* murrain has formed but a small share of what really existed. We cannot suggest a spot in India in which we believe that both forms have never occurred; but while this is true, it is true also that in any one year the geographical distribution of murrains will show large blanks of murrain-free divisions and districts, or smaller areas. Were inquiry more minute, these blanks would probably be smaller and fewer than they are believed to be, and in places such as Calcutta, where cattle are massed, an annual murrain map would show an annual murrain tint; but it is these blanks which give cause and room for action. If they did not exist, action would be impossible, and the aim of action must be to preserve from year to year the blanks which exist and extend them. In a district checkered, as many or most, will be found to be, with murrain patches, action must be correspondingly detailed and difficult. It is hardly necessary to suggest that an annual murrain map for India, showing accurately the areas affected, would be of itself a very interesting and important record.

Murrain map.

Number of cattle.

7. The number of cattle in a certain area has in no instance been precisely estimated, nor can any reliable general statement be made with regard to the effect of crowding on the prevalence of murrain. The general rule may be accepted as true that a sparsely scattered stock affords an unfavourable condition for the spread of disease, and a crowded stock the reverse; but the universal practice of herding invariably provides for more or less massing, and even in cases when an estimate of stock to area would show a low figure, this practice provides for all the conditions of dense crowding and its necessary concomitant of incessant intercourse. The state of the byres and oilmen's sheds of Calcutta affords the best illustration possible of the evil effect of crowding. When disease enters these byres or sheds, it does not leave a single susceptible animal unattacked. One very important fact regarding the proportion of stock to owners and land was elicited at Chuadanga in the Nuddea District, namely, that owing to the increased relative proportion of land brought under cultivation, the consequent decrease of pasture land and the increased number of persons engaged in agriculture, the number of cattle which each owner possesses has been reduced to the minimum; whereas in former years ryots always owned a surplus of cattle and as the people of Assam now do, held cattle as a representative of means or wealth; now their value consists in their work as agents for agricultural production. The same is true of dairy stock which, in the Presidency Division, is held as a means of producing milk, *ghi*, etc., which are the source of gain. The effect of increased demand of animals for slaughter, on both number and value, is testified by many witnesses and is no doubt important and true. As the surplus and unproductive stock of the country becomes less, as cattle become less a representative of wealth, and more an agency of wealth, the subject of losses by murrain will assume a greater importance and attract a closer attention and interest, and the necessity for repressive measures becomes more declared and pressing.

Herding.

Calcutta byres.

Relative diminution of stock.

Breeds.

8. A consideration of the breeds of cattle does not form part of our instructions or purpose, but a great deal of information on this subject is

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scattered through the appended evidence. While, with very few exceptions all the cattle which passed under our observation belonged to the humped or Zebu kind, the quality varied greatly, from the puny degenerate Assam bullock to the magnificent Hissar, Hansi, and Gujerat animal. It is curious to note that while the Assam cattle are the worst in India, the Assam buffaloes are undoubtedly the finest. This results from an intermixture of the Bengal breed with the wild buffalo, and shows what judicious breeding may accomplish. We commend the subject of systematic improvement of breed to the notice of those interested in stock; but we would strongly endorse the opinion of Mr. John Stalkartt who speaks with the authority of practical experience, that the introduction of foreign breed into India is a mistake. In truth some of the Indian breeds cannot be improved on, leaving adaptation to the country and its wants out of sight On the other hand, Babu Joy Kissen Mookerjee, an influential and intelligent Zamindar of Hugli, states that his experiments in breeding have not been successful. This is therefore a question for careful trial. The results of systematic breeding, as observed by us in the Hissar Stud Farm, show that fine animals for all purposes may be obtained by the judicious crossing and feeding of native stock.

Improvement of breed. **Mr. J. Stalkartt's evidence.** **Babu Joy Kissen Mookerjee's opinion.**

Value of cattle. Prices increased.

9. The value of cattle has a more intimate relation to the subject of cattle plague. It will be observed that the universal testimony obtained everywhere is to the effect that within the last ten years the price of stock has risen. The rise is variously estimated at 10, 20, 25, 50, or even 100 per cent. This result has in some cases been attributed to mortality from disease,—and a temporary local rise in price does no doubt take place occasionally from this cause,—but the universal rise of the price of horned stocks has by all our most intelligent informers been attributed to other causes of wider and deeper influence than loss of cattle by disease, which is local and transient. Stock has become more valuable and money cheaper, The greater demand for produce, the keener cultivation, the increase of cultivated area, and the consequent enhanced demand for cattle are truer reasons and in some places the influence in this direction of an increased agricultural activity is most marked. The effect of the tea enterprise in Assam is an excellent illustration, because the people have, even after severe murrain, a surplus of cattle. From this it follows:—

Causes.

1st.—That the loss of cattle is a more serious matter now than it was to all agriculturists.

2nd.—That the need of adopting measures to protect against loss is more urgent now, and yearly becoming till more so.

A mantuar bullock.

A striking, and no doubt true, observation on this subject is made by the Commissioner of Kumaun who remarks that a *māntuar* bullock or buffalo, that is an animal that has recovered from an attack of *mān* (rinderpest), is more valuable than one which has not had the disease. The same fact is mentioned in an official report on cattle disease in the Netherlands (*1st Report of the English Cattle Plague Commission, Appendix, page 187*).

While the principal value of this observation is the practical demonstration it affords of the circumstance that one attack protects against a subsequent one, and of the value of a rightly devised and executed system of inoculation, it also shows that the existence of murrain has in some places had a palpable influence on the price of stock. It may reasonably be expected that, as agriculture spreads, and the value of stock becomes still greater, the effect of murrain on price will become more striking, and that the circumstances of numbers diminished in relation to demand, use, and need, with the inevitable enhancement of price, will combine

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to urge the subject of murrain more and more strongly and closely on the attention of Government.

10. The problems suggested by the preceding paragraphs are capable only of complete solution locally from local study, but the conditions of their study are incomplete without a periodical census and correct registration of other data involved relating to the agriculture of the country. It would be a most important matter to ascertain accurately the price of cattle of different kinds at the principal fairs and local markets, and publish it periodically in the provincial Gazettes. The necessity of this is obvious, and its absence an evidence of the backward and primitive condition of matters relating to agriculture and stock in India. We accordingly submit this as a recommendation to which we attach very considerable importance, and which is capable of easy accomplishment at once, while the enumeration of cattle, though we feel it our duty to urge this also, is a matter of much greater difficulty, and its results subject to much greater doubt. (Census of cattle.) (Market prices.)

11. The usage for which cattle are employed form an important part of the consideration of the conditions of their existence which render them more or less obnoxious to attack by epizootic or contagious disease. This subject has been so amply discussed in the paper printed as a separate *Ledger* that we need only refer to it here, and remark that all our inquiries, in which we held the facilities for the spread of disease depending on the circumstances, life, and employment of stock constantly in view, have amply confirmed every word that is written there. These circumstances may be briefly recapitulated as follows:— (Use for which cattle are employed.)

1st.—Cattle associate freely on roads, paths, and fields during the cultivating season in working hours. (Association at work.)

2nd.—They associate on the pasture fields (where there are pasture fields) during non-working hours, generally the afternoon. (Association at pasture.)

3rd.—They are housed together in confined sheds. (Housing.)

4th.—During non-working seasons they are herded. The stubble fields are then available for pasture, and the cattle of different villages meet and associate indiscriminately. This was particularly noticed in Assam, where a circle of villages surrounds a large rice tract (*pittar*) in which, when the crops are cut, hundreds of cattle roam at will. (Herding.)

5th.—During the same season, when not wanted in other places, they are driven in droves to more fertile tracts. They contract disease there, and bring it back to their villages when they are wanted for cultivation. (Herding and droving.)

6th.—As beasts of draught and burden, they travel long distances along roads, resting in *bazars* or *sarais*, and, meeting other cattle there, contract or disseminate disease. (Draught and burden.)

7th.—As dairy cattle, they are pent closely up in confined sheds and the stock is periodically renewed; and if a new purchase brings disease, it spreads unfailingly among the rest. (Dairy.)

8th.—For slaughtering purposes cattle are droved and driven on roads, and may contract and scatter disease without limit. (Slaughter.)

9th.—There is a complete absence of any system of *fencing* in India, or that artificial boundary of property or farm which elsewhere supplies one of the main conditions and most essential postulates of a system of segregation. (Absence of fencing.)

In a word, the facilities for the spread of a disease are infinite, and in considering the question of local remedial measures, these facilities must be studied in elaborate detail. While, generally, similar practices prevail over the whole country, which may be described in a few words, our observations exhibit a diversity of local peculiarities which must be carefully (Local enquiry necessary.)

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inquired into as a preliminary to any action. Such a practice, for instance, as that described by the villagers of Kamnara near Burdwan—driving milch cattle to Howrah during the cold weather—would have a most powerful influence in spreading disease, and must be known in order to have this influence obviated. Much of this kind of information is given in our report, but the local conditions governing the problem of prevention must be exhaustively studied in each locality before effectual preventive measures can be devised.

Housing of cattle.

12. The housing of cattle is an almost universal practice, and, as a rule, we have found the sheds used well adapted for their purpose. On this head we have no suggestion to offer, except that, in some instances, they are manifestly overcrowded. The Calcutta cattle dairies, for instance, are as crowded as they can be, and the arrangements for removing filth are exceedingly defective.

Feeding and watering.

13. The system of feeding and watering cattle has invariably been inquired into, and it is evident that there is room for reformation here. In some places feeding is well understood and is reduced to a system, as in the Calcutta dairies and oil sheds, where the kind, cost and effect on milk of various plans of feeding are well known. Again, in the district of Nuddea the feeding of plough and dairy cattle, in relation to work and produce, is well understood; but, as a rule, feeding and watering are left very much to the will of the animals. The evidence of Mr. Farrell upon this point is of more extended application than merely to the localities visited by him. There are several specific results of this want of care and system.

Effects of improper feeding.

1st.—During the cultivating season when much land is under crop, pasturage is reduced to a minimum, and work is severe; unless fodder is systematically stored and cattle are stall fed, they fall off in condition. In Nuddea the cultivators had, owing to the want of pasture, learnt to store and stall feed; but this is by no means the case invariably.

2nd.—During the dry months, in many places, the herbage is so scanty and dry that innutrition, wasting, and impaction (Fardel-bound) are the consequences. A good illustration of this was observed at Mohunneah in the district of Shahabad where, during the two days we stayed there, two fatal cases of this sort occurred, and were examined.

3rd.—The effect of bad pasturage in causing serious mortality is exemplified in the *bhukni* of the Gujranwala and Jhang bar in the Panjab.

4th.—In 1869 an absolute scarcity of fodder caused, in some districts of the North-Western Provinces, a great loss of cattle by starvation; this resulted from simple improvidence.

5th.—After the first shower of the rains a delicate rich growth of young shoots takes place. The cattle, previously starved and accustomed to the driest pasture, browse eagerly on this sweet succulent herbage and the consequence is a fatal attack of hoven. This is a universal observation, and many cases of the mysterious *puschima* of Lower Bengal would appear to consist simply of this condition thus caused.

6th.—The effect of a too rich pasture after a dry season in causing "quarter-ill" is well known and clearly brought out in Mr. Dawson's reports on the Hissar murrain of 1864. The rational remedy of exercise and change of pasture has been adopted there as a standing rule.

7th.—The evil effect of eating grass which has been submerged is very frequently alluded to in the evidence and reports, but no opportunity occurred of studying practically the effects of this kind of pasture. It is a subject worthy of attention.

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8th.—In many places particular kinds of grasses and herbs have been credited with causing disease. The only observation on his head which we had an opportunity of making was at Chuadanga, where two cases of death from eating castor-oil seeds and leaves were seen and examined *post mortem*. These considerations are sufficient to prove that the study of the food of cattle and the storing of fodder is a desideratum. On this subject much information has been collected, and it is one worthy of practical attention. The various kinds of grass available for cattle food in different places have been carefully enumerated, but, for practical purposes, this kind of information must be more local and exact. The serious question of pasture land is one which we would particularly bring to notice. The old religious rule which prescribed the reservation of a certain proportion of the surface for pasturing cattle has in many places been forgotten in the struggle of increased remunerative cultivation. This matter demands special inquiry and treatment, and is foreign to the subject in hand, but we allude to it in order to record our belief that it is a most important one, and deserving of careful and practical attention.

Pasture land.

The watering of cattle is conducted on the same hap-hazard principle as their feeding. Watering-places afford a means of spreading disease, and it is highly probable water itself may. In the centre of a village of Etawah—Fakirpur—we saw a small pond containing gruelly-green fluid in which cattle wallowed at will, and on whose banks cases labouring under rinderpest were seen. A place of this sort is nothing else than a pit in which healthy cattle bathe in diluted rinderpest discharges. It was an extreme case, but by no means an uncommon one. The single case of rinderpest which had occurred in a village of Burdwan—Gangpur—had not only been housed and fed separately, but watered in a separate pond. This matter of common watering-places must not be lost sight of in any scheme of segregation Enough is not known of the contagium to say that it does or may act through or by water, but the necessity of the precaution is obvious. Cattle labouring under rinderpest have an abnormal thirst and make for ponds and watering-places, and the observation has frequently been made that their carcasses are more apt to be found near tanks, ponds, etc. The quality of the water which cattle have to drink is in some cases very bad, as in the instance of the Calcutta dairies. A filthy fluid containing all kinds of abominations is plainly improper

Watering.

14. The subject of herding is undoubtedly one of the most important in considering the spread of contagious disease and its prevention. The following are the principal kinds of herding practised in Bengal:—

Herding.

1st.—Herding for pasture, when the cattle of different homesteads or villages are collected and driven to a fallow field or tract where they mix together.

This practice is universal, and a necessary adjunct of the village system.

2nd.—Herding for pasture when cattle are driven to other and distant places for pasture.

This practice is a very frequent one.

3rd.—Herding on breeding tracts.

4th.—Herding and droving for market.

5th.—Herding and droving for sale amongst villages.

All of these varieties of herding, which have been made a part of the local inquiry, are simply so many agencies of the spread of infectious diseases, and in any plan of preventive effort they must, as such, be minutely taken count of.

OXEN.	Selections from Report of Indian Cattle

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Supply of stock. **Local breeding.** **Streams of cattle movement**

15 The necessities of replenishing stock furnish another channel of spreading disease, and the modes of replacing losses by age, injury, or disease must be studied with a view to preventive action

Local breeding is a universal thing in Indian villages, but it does not serve to supply the demand of populous districts where agriculture is briskly carried on (*e g*, 24-Parganas and Nuddea), while in other places (*e.g*, Palamau, the Tarai, and Orissa) where pasture land is abundant, breeding exceeds the local demand, and thus a definite system of cattle movement and trade has arisen. The streams of cattle movement do not, however, depend solely on agricultural demand, but, where cattle are used for their meat or milk, an additional demand arises These causes determine certain constant routes of cattle droving which are liable to little variation.

Many of these have been studied and displayed, but these streams must be accurately defined in each district We need only here refer very generally to the wide radii of cattle movement which the wants of Calcutta have created, to the constant stream of cattle from the breeding grounds of the Tarai to the central districts, and to the stream of buffaloes proceeding from Bengal to Assam every cold weather to illustrate this point. In times of impending murrain these streams must be studied, watched, and, so to speak, temporarily dammed up. The principal circumstance connected with breeding which tends to spread disease is the hap-hazard way in which it is conducted Bulls, whether Brahmini bulls or village bulls, are allowed to roam at will, and may carry disease about with them without hindrance

Markets.

16 The subject of markets has been held prominently in view. Their influence in spreading disease need not be urged here, it is too well known · but the private bargain system or village-to-village or person-to-person dealing, is not without its dangers Mr. Farrell in his evidence gives two good examples of disease spread in this way We had, at Puddobelah, in the Nuddea district, a good opportunity of observing what a local market may do in the way of disseminating rinderpest. Cattle actually labouring under the disease were seen at this fair in association with healthly animals brought from a wide circle and destined to travel to widely separated places We also saw cases of foot and mouth disease at the Ulubaria fair The outbreak of the same disease—rinderpest—in Benares and Dinapur in 1869 was clearly traced to the same fair, Kat Berhampur in the Shahabad district.

Calcutta markets.

The important markets around Calcutta were made a subject of special and careful attention. In any scheme of preventive action, it is obvious that cattle markets must be considered, and the importance of skilled inspection and exclusion of diseased cattle need not be urged.

Hide trade.

17. Much information regarding the trade in hides will be found scattered throughout the evidence recorded in the sequel. It is quite certain that the hides of cattle dead of rinderpest are, all over India, with the exception of Assam and the Sundarbans, removed and carried throughout the country after being sun-dried or imperfectly cured This is a very large industry, and any unnecessary interference with it would be a hardship and loss to hundreds; but, though no specific instance of conveyance of disease by the agency of hides has come under our notice, there is every reason to think that it may be thus conveyed, and preventive action, to obviate this risk, must provide for the destruction or disinfection of hides. We would recommend the adoption of the latter course. Efficient soaking in lime or salt and water, as is done in many cases, is known to render the hide innocuous, as far as conveyance of disease is concerned, but at least 3 or 4 seers of lime or salt

DISEASE OF STOCK.

must be used for each piece, and the thing must be done thoroughly and systematically *on the spot.* If this cannot be attained, then the scoring and burial of skins, or their destruction in any other way, is imperative. No hesitation should exist when the alternatives are a few hides and many living cattle. The subject of cattle poisoning and its relation to the hide trade have been carefully studied, and the results of investigation show that the allegation that all, or most, of the murrains of Bengal are cattle poisoning has been proved groundless by the extended investigations we have made, and the fact that in Assam and the Sundarbans, where no trade in hides exists, disease is as rife as elsewhere.

Cattle poisoning

18. Having thus lightly touched upon the conditions under which cattle exist, as regulating the origin or spread of murrain,—and the analytical index we have prepared will provide a key to a more elaborate study of all the information which has been amassed on each subject,—we now proceed to set forth the principal conclusions at which we have arrived regarding—

III.—DISEASES OF STOCK.

History of murrains.

19. As regards the history of murrains, little need be said here. All the information gathered under this head has been given in the "historical sketches" of every division, in which all the recorded outbreaks in each district have been shortly described in chronological order. The amount of past disease of cattle everywhere, which these sketches reveal, will excite surprise, but it is small in proportion to what might have been given, had attention been continuously directed to the subject. Only in case of the Andaman Islands have we been able to obtain the date of the first outbreak; everywhere else there are mere glimpses of periodical prevalence stretching back towards or into the last century. We made every endeavour to trace any tradition or allusion in old Hindoo chronicles to the subject of murrain, but without success. The series of maps* which we have prepared from the records at our disposal show a gradual increase of disease, but this, we are convinced, is more apparent than real, and is evidence of increased knowledge rather than increased disease. It is to be earnestly hoped that every outbreak which occurs will now be carefully studied and properly recorded, and that some correct idea may be furnished continuously, not only of the chronology of murrains, but of their area of distribution. This must depend entirely upon local effort, and we have had sufficient experience to convince us that local effort must be stimulated in this direction. Unless there is some department which will furnish this stimulus and record results, valuable information must be lost; and if events are not recorded as they occur, the demonstrated general prevalence of 1870 will be succeeded by an apparent absence of murrain in 1871. Thus, the teachings of the past will be of no avail with regard to precautions against the future, and no more definite truths than that murrains prevail periodically in particular places, and always somewhere, will be available for guidance. With regard to the first appearance or origin of murrains in India, we are and shall remain in complete ignorance.

Narratives of outbreaks wanted.

Diseases of horned cattle.

20. The most important diseases of horned stock of which we have obtained experience or authentic information are:—

1st.—Rinderpest,
2nd.—Foot and mouth disease.

* Not issued.

DISEASES OF STOCK.

3rd.—Hoven.
4th.—Quarter-ill.
5th.—Pleuro-pneumonia (ordinary ?).
6th.—Bhuknī or purging.
7th —Cystic disease.
8th.—Throat swelling.

Reserving rinderpest for special consideration, we shall shortly state the conclusions at which we have arrived regarding the others.

Foot and mouth disease.

21. *Foot and mouth disease* is a universal disease of cattle in India, causing a considerable amount of sickness yearly, much disabling of cattle, considerable inconvenience, but no great mortality. It appears to be even more common and frequent than any other form of cattle disease, and, if we may judge from the experience of the Andaman Islands, more penetrating and persisting. It generally appears in the hot season, but may prevail at other times. Villagers everywhere in India—Bengal, Madras, Bombay, etc.—and Ceylon are familiar with it, and have eagerly attested its existence even where the severer disease was denied or concealed. Allusions to it occur almost on every page. Cases of this disease were seen at Chuadanga and Ulubaria and a regular epizootic studied at Darjeeling in October. In this case the infectious nature of the malady and its disastrous consequences under some circumstances were very apparent. The circumstances causing exceptional severity in this instance were,—working the animals after the disease had commenced and, apparently, a colder climate. A case exactly parallel is described by Mr. Thacker in his Madras reports.

Prevalence.

Names.

The vernacular names by which this disease is known are very various, but generally derived from words signifying mouth and foot separately or in combination,—*mohpuccah*, *khurpuccah*, *muhkhur*, etc., etc. The symptoms of this malady need not be detailed here; they are well known. The most frequent cause of death is inability to feed owing to disease of the mouth, or severe ulceration of the feet, owing to the development of maggots. The native methods of treatment are various. The most common plan is keeping the cattle standing in muddy water; this prevents the access of flies. Various astringent barks, *babul*, etc., are also applied in some places. The undoubtedly infectious nature of this disease suggests the propriety of isolating the sick and segregating the healthy, destruction of litter, and disinfection; and, during the cultivating season, it is obvious that precautions must be redoubled, in order to prevent the interference with work which this disease causes; but, considering the mild nature of the disease under a proper system of treatment, it is questionable whether greater inconvenience and loss of time and money would not be entailed by elaborate preventive measures than by any sickness which might prevail, notwithstanding cleanliness, disinfection, and simple precautions. As regards medical treatment. nothing can be better than carbolic acid and oil (1 part to 40), or camphor and oil (1 oz. to a pint), as an application to the feet and to prevent access of flies, and a watery solution of alum (10 grs. to 1 oz) as a wash for the mouth. A mild laxative might be administered at the outset, and it is of the utmost importance to sustain the strength with soft mashes, rice gruel, etc. Keeping the affected parts clean is of great importance, and a poultice may occasionally be useful. Detached portions of the hoofs should be removed. If this plan is adopted the loss from foot and mouth disease will be very trifling. The question of the power of one attack to protect against a second was constantly held in view, but we were unable to arrive at any definite

Treatment.

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solution of it. The general testimony of the people was to the effect that one attack was not protective; in this we concur, and it is all the more remarkable in contrast with the almost unanimous belief they expressed in the protective power of one attack of rinderpest.

Hoven.

22. *Hoven* is an exceedingly common form of fatal disease among Indian cattle, and vivid descriptions of it met us at every turn. It is dependent upon errors of diet, and consists of suffocation from over-distention of the rumen with food or flatus. It is known by a great variety of names, and is most common in the early rains. There can be no doubt that much of the *puschima* of which we heard so much in the Presidency and Burdwan divisions, is hoven. In general, it has a more expressive name; *pet bhagi* (swollen stomach) is a very common term, or some equivalent. After a smart shower of the early rains, when succulent shoots spring up as if by magic, cattle which have been nearly starved for weeks are apt to over-feed themselves. Several animals of a herd, or among a village stock, may thus be seized with hoven, and the affection may almost appear epizootic. It is obvious that, as long as no care and system are pursued in regulating cattle feeding, they will be liable to this disease as often as a cause arises, and there can be little doubt that cases of this sort are often mistaken for murrain or poisoning. Another condition, which also proceeds from improper feeding, is impacted stomach, caused by animals in the dry weather having to subsist on withered stems or dry roots of grass. Two cases of this sort were seen at Bhabua in Shahabad, and they are no doubt very common. The treatment of cases of this description need not be entered upon here; it is matter of common veterinary practice. We are convinced that a large aggregate body of stock yearly fall victims to this preventible and curable form of disease, and its wide-spread existence constitutes one of the best possible arguments for the diffusion of veterinary knowledge and skill. The simple and successful operation of tapping the rumen is not even known to the people, and in many parts of the country the disease is thought to be incurable.

Fardel-bound.

Diffusion of veterinary knowledge.

Quarter-ill.

23. The existence of *quarter-ill* has been more clearly proved in the Panjab than elsewhere. Mr. Dawson's valuable reports leave no doubt as to the state of the case at Hissar, and the testimony of the inhabitants of the Panjab in many instances showed that the disease was not confined to Hissar. Mr. Farrell met with the disease in the Sundarbans, and from the evidence of the villagers of Daulat Daiár, it is evident that the term *puschima* covers cases of this kind also. This class of diseases is well known, as regards causes, pathology, and treatment, and, as they owe their origin to causes which may affect the members of a herd in common, they may assume the aspect of an epizootic; indeed, it will be observed that Mr. Dawson gives advice for the sanitary treatment of the Hissar murrain on the theory of its contagiousness, for which, in this country, there is every ground of belief. Whether this is true of this disease or class of diseases or not, it is very plain that precautionary measures are those which give the only prospect of success, and the measures recommended by Mr. Dawson, which need not be recapitulated here, are very excellent. Care in dieting, change of pasture, and intelligent watching are the measures most promising of success, and this class of diseases, which in many cases almost amount to a murrain, and do, we believe, cause much destruction of stock, supply another argument for the spread of sound views regarding the sanitary and medical treatment of stock throughout rural India.

Pleuro-pneumonia.

24. *Pleuro-pneumonia* is undoubtedly met with in some parts of India, and convincing evidence of the existence of this disease was obtained in the Panjab, where cases were seen and examined *post-mortem*.

OXEN.	Selections from Report of Indian Cattle

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The people of the Panjab were very familiar with the disease and described its symptoms accurately. It is called *phípri*; 172·9 deaths from this cause is the yearly average of the Hissar return, or nearly 2 per cent. of stock. The disease would also appear to be common in Sind; it is possible that it may have been originally introduced into the stud farm at Hissar, and thence disseminated throughout the Panjab and Sind. The evidence collected in the Panjab would go to show that the disease is, and has been, a common and destructive one, but not so general or destructive as rinderpest or *bhukní* when it occurs. It appears, as a rule, in this country to be more sporadic than epizootic. The general opinion seems to be that it is not contagious; but, in the face of the evidence on this point which has accrued from Australia, South Africa, and the United Kingdom, the theory of contagiousness should be the guide to action, and segregation and disinfection should be scrupulously practised. The disease has not acquired that prominence or importance as a cause of sickness and loss of stock which would suggest a trial of inoculation—at best an expedient of very doubtful advantage, as has been proved in Great Britain and Australia. More careful inquiry than we had time or opportunity to make is evidently highly desirable, but, as far as our inquiry has gone, we cannot conclude that pleuro-pneumonia has anywhere attained the dimensions of a murrain, or need occasion general alarm. Any investigation on this subject should be local, as circumstantial as possible, and the work of a skilled agent.

***Bhukní* or purging.**

25. *Bhukní* or purging we have no hesitation in pronouncing an endemic, strictly confined to certain parts of the Panjab, *viz.*, the *bar* of the districts of Gujranwala and Jhang. From all the evidence recorded upon the subject, there can be little doubt that it is a disease of improper diet and watering, occurring to an exceptionally severe extent in an exceptionally dry year, and its remedy is plain—good pasture or fodder and good water. How to obtain this in years of drought, such as 1869 is no easy question, but one to be solved locally. The witnesses examined on the subject were very clear as to the difference between this disease and rinderpest, and, from a comparison of the symptoms, no reasonable doubt can exist on this point. Some of the men examined thought the disease contagious; but this is a natural but erroneous inference from the circumstance of a disease affecting many cattle simultaneously, and apparently from association because in association, while they are subject to a common cause of disease. The Tahsildar of Jhang found that the disease ceased everywhere when rain fell.

Cyst disease.

26. The infection of cattle by *cysts* is a very important subject, because one form of the disease is so universal in India, and the relation of the malady to some human diseases is so well known and so serious a matter.

The hydatid cysts or the immature tænia echinococcus, which in its mature condition is harboured by dogs, and probably wolves and jackals, are found all over India affecting the liver, lungs, and spleens of cattle. The extent to which these cysts exist among cattle in Calcutta is shown by the observations made at the slaughter-houses. Public attention has been more particularly drawn to this subject in the Panjab than elsewhere, on account of the difficulties which these cysts occasioned in the matter of meat-supply. Dr. Fleming enters upon the question of preventive sanitary measures, which, as far as the beef tapeworm is concerned, we entirely endorse; but the question of preventing the other variety of cysts is a much more difficult matter, and one on which we cannot offer any suggestion which would prove practicable as regards the cattle of the country at large, as the disease is probably disseminated by dogs,

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jackals, etc. No doubt stall-feeding and scrupulous cleanliness and care would exclude the ova of the tapeworm, but this is, as regards agricultural and village cattle, simply impossible. It does not enter into the scope of our instructions to discuss this subject elaborately, which is the less possible, as the facts on which any discussion might be founded are very far from exhaustive. We believe that it might be usefully worked out, as far as opportunities offer, by the Veterinary Department and the Officers of the British and Indian Medical Services, and we accordingly commend it to notice for investigation. Late public reports on the subject would apparently show that these cysts are not so common now as when attention was first drawn to the subject in 1866; but that this is not the case the observations show, and although rejections of meat by the Commissariat have, we believe, in accordance with the views of Dr. Muir, C.B., Inspector General of Hospitals, British Forces, been much fewer, there is no reason to believe that the number of carcasses in which cysts of one sort or other are found is smaller than it was. The figures quoted in public records upon this subject are founded on the records of *rejections*, and do not therefore represent the true state of the case. We are convinced that cyst disease is universal among Indian cattle, and that this is a subject worthy of extended investigation by the medical and veterinary officers scattered over India. The results of individual inquiry might be collated by the heads of these departments for the information of Government.

Throat disease.

27. *Throat disease* will be found frequently alluded to in the reports of district officers, and very few schemes of cattle disease submitted do not contain, under some name or other, an allusion to this affection. We have not been so fortunate as to see a single case of this swelling of the throat, and are inclined to believe that it is either a symptom of some other disease—rinderpest or quarter-ill—caused by swelling of the parotid and submaxillary glands or effusion of blood into the subcutaneous tissue of the neck and dewlap, or a kind of mumps—a disease which is not uncommon as an epidemic among communities in India. The disease is epizootic and fatal among cattle. The native treatment is firing externally, and this seems to be successful in many cases.

Other diseases of stock.

28. The foregoing are some of the most prominent diseases causing sickness and death among cattle in India. They have been briefly treated of, and the catalogue of affections to which cattle are liable is no doubt as long in India as elsewhere, though, with the exception of Dr. Gilchrist's "*Practical Treatise*" which contains a description of many forms of cattle disease drawn from his own experience, no other systematic record of Indian origin exists. This book has hitherto been the only guide available for officers in charge of commissariat and artillery cattle, and as the directions for treatment which it contains are antiquated and inconsistent with the advanced pathology of the present day, it should not be so generally and infallibly relied upon as it apparently is. Indeed, there is every reason that Government cattle as well as horses should obtain the best veterinary advice when that is available. We understand that such is not the case now, and would urge strongly that in whatever station a veterinary surgeon's services are available in the Bengal Presidency, they should, as in Bombay, be employed for the treatment of sick Government cattle. A large mass of valuable experience is moreover thus available which is lost upon the unskilled men who undertake the treatment of ailing cattle, and which might be fixed for scientific purposes or utilisation, as far as the cattle of the country are concerned. Any effort to apply veterinary knowledge or skill in India must in the first instance be made through the veterinary sur-

Government cattle should be placed in medical charge of Veterinary Surgeons.

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geons of the public service, and it is unfortunate that they are debarred from the only source of information and experience which is available for them, and sound advice on such subjects is now expected of them, while the special experience on which it should be founded is denied. Valuable experience is also available at the Government cattle farm at Hissar and Hunsur, which is not fixed or utilised, and it is matter of regret that this large field of observation is lost for purposes of systematic examination and record of the diseases of cattle.

IV.—RINDERPEST.

29. We now come to the main and central object and subject of our labours,—the murrain to which a far greater share of mortality among cattle is due than to all other causes put together,—namely, that to which we have applied the term *rinderpest.* That this term has been appropriately applied, the evidence which we have collected and sifted leaves no reasonable doubt. After a careful study of the features of the disease in Europe, as recorded in the reports of the English Cattle Plague Commission and Veterinary Department of the Privy Council, and in systematic works; an exhaustive consideration of all that has been written on the subject in India and Ceylon; an extended and minute inquiry, oral and documentary; a very large experience of the disease as manifested by living animals in a great many parts of the Presidency of Bengal, and an elaborate practical study of the *post-mortem* and microscopic appearances of the organs and tissues of subjects which have died of the disease,—we have, without any prejudice or pre-conceived opinion to misguide us, deliberately and decidedly arrived at the conclusion that this Indian murrain is identical with the Steppe plague or murrain of Europe and Russia in Asia, and is essentially the same disease as that which devastated the flocks of England in 1865-66. It is impossible to compare diseases which vary with varying circumstances of breed, country, climate, and other life conditions, so accurately as to exhibit exact identities spreading in every case into every detail; but taking a broad view of the nature and behaviour of this murrain, as displayed so copiously, and in many cases elaborately, by numerous independent witnesses in the succeeding pages, the resemblance is complete, whether we take the whole history of an outbreak, the whole *ensemble* of the phenomena of cases, or particular symptoms or pathological features.

Identity of Indian and European rinderpest.

This opinion has invariably been arrived at by medical men and veterinarians who have made the disease a special study. Dr. Gilchrist in 1848 pronounced the *bara asar* of Madras to be the same as the "murrain of Europe." Dr. O. Palmer had, in 1864, no hesitation in calling the Calcutta epizootic *rinderpest.* Mr. Gudgin, V. S., after carefully studying the epizootic in Burmah in 1866, arrived at the same conclusion.

Opinions of Medical and Veterinary authorities.

Mr. Thacker, V. S., from a large practical experience in Madras, extending over many years, has unreservedly adopted the same view. Mr. Barrow, V. S., who had been a Government Inspector in the County of Cambridge during the outbreak of rinderpest in England, concluded that the epizootic which he studied in Benares in 1869 was "analogous" to the Steppe murrain, rinderpest, or cattle plague that ravaged the herds in various parts of England during the years 1864, 1865, and 1866. Mr. Stanley, V. S., acknowledges that this same Benares disease "somewhat resembles the rinderpest of Europe," though he doubted its identity, owing to its milder character and the absence of some characteristic phenomena. Mr. Stanley had only seen seven cases of the disease, and remarks very justly that the Steppe murrain is far less fatal in the Steppes than elsewhere. Mr. Farrell, V. S., who gained a wide experience in Bengal

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and Assam, has no doubt or hesitation on the subject. And, lastly, the Ceylon Cattle Disease Commission pronounce the following judgment upon the Ceylon murrain:—"It is identical in its leading features with the rinderpest of Europe *and India*, differing only to such an extent and in such a manner as might be reasonably expected under the varying circumstances in which cattle are placed in this country" (page 10 of their report). We would not build too strongly on opinions, although their unanimity and the independent manner in which they have been arrived at are weighty points. The variations which may be noted between the English plague and our descriptions are no greater than we have ourselves noted in different forms of the disease in this country, and no greater than may be observed in the case of foot and mouth disease, human small-pox, and cholera. The comparison between the English and Indian disease is indeed not a fair one, because circumstances and climate are so different. A more reasonable parallel is afforded by the plague as it exists in Asiatic Russia, and, as far as the records to which we have had access inform us, the Russian disease is in Russia exactly the same in every respect as the Indian disease in India.

The only certain test of identity.

We do not propose to enter into an elaborate analysis of both diseases for the purpose of proving or fortifying our position. After the experience we have gained and consideration we have given the subject, we have formed the opinion which we have above recorded, and we have furnished materials of every kind in this report by which its validity may be judged, and the specimens we have collected, and drawings which we have had executed, afford still further tests. If anything further is wanted, the matter may finally be set at rest by inoculation, under proper precautions, of cattle in England by material derived from the Indian plague. We do not undertake the responsibility of initiating or advising this crucial test, for we are too assured of the nature of the Indian plague to doubt its danger and impropriety; but it is incumbent on those who do not accept our conclusions, and cannot demonstrate their futility from the evidence on which they have been founded, to adopt the only means by which any doubt may be for ever removed.

Contagiousness and importability.

30. Whatever doubt may exist regarding pathological identities, there can be no doubt regarding those features of the disease on which preventive action depends, namely, contagiousness and importability; so that, for practical purposes, varieties of type are of little concern while we have to do with a febrile or exanthematous disease, killing more than half the cattle it attacks, and eminently infectious. On this subject of contagiousness the evidence recorded has been almost unanimous, and this unanimity is so strong, clear, and universal, that it would almost appear superfluous to illustrate or discuss the matter. Reporters and witnesses have expressed themselves without hesitation on the subject, and in many cases have given striking instances in support. The introduction of cattle plague into the cantonment of Dibrughar on two separate occasions, in 1854 and 1869, in exactly the same manner, namely, by sepoys rejoining the head-quarters of their regiment from Golaghát, is a remarkable instance of infectiousness and importability. Other very well marked illustrations were found in the papers relating to the Assam Division. A curious instance of importation of disease into a sound village is the following. Some of the cattle of a healthy village were impounded for trespass in an affected village, and carried back the disease with them. Villagers almost invariably told us whence the disease came, and, as a rule, attributed its origin to previous prevalence in an adjoining village and association of cattle on the pasture field. When the origin could not be explained, the cause was most probably want of

Opinions.

Instances.

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power of accurate and intelligent observation. The progress of the disease in a village was generally traceable. The first two or three houses in which it appeared were, as a rule, contiguous; and then, as the amount of contagium was multiplied, it became general, and its spread dependent on the numerous accidents of unrestrained intercourse. In some cases, the villagers pointed to the purchase of a diseased animal, and the introduction of the murrain from the grazing tracts of the Tarai and elsewhere into the villages of the adjoining districts is illustrated frequently.

Whether, then, the broad features of the movement of this disease across the country, or the circumstances of its progression in a village, or facts regarding the infection of particular animals or of a single shed or byre, be considered, they all point in one direction, indicating that diseased animals are the principal agency of the propagation of this disease. Negative evidence regarding the salutary effects of a *cordon* or segregation or removal of healthy cattle, points in the same direction; but in order to place the matter beyond a doubt, healthy animals bought from healthy villages were experimentally associated with those labouring under disease, with the invariable result of unfailing infection. Satisfied of the communicability of the disease from animal to animal, an attempt was made to determine up to what distance the disease was capable of conveyance. The general result of these trials warrants the conclusion that, with proper precautions, a distance of 30 yards is sufficient of itself to secure immunity; but as the contagium is portable, it is obvious that safety at any distance must depend upon the strictness with which possible conveyance is guarded against. The infecting material is contained in all the discharges which so abundantly issue from the mucous orifices of the animal and in the scales shed from the skin; and it is more than probable that, in a dried condition, it may be capable of conveyance by a strong wind to a considerable distance. The results obtained artificially are not therefore to be adopted as safe ground of action, unless the precautions against conveyance are carefully imitated. The salutary results of careful isolation in the midst of a severe murrain exhibited in the village of Akna are confirmatory of these conclusions.

Proved experimentally.

Infecting distance.

Conclusions.

As far as our observation has gone, we believe,—(1) that this murrain is a highly infectious one; (2) that its propagation is due mainly or entirely to that circumstance; (3) that all the incidents of particular outbreaks, if properly investigated, and with a due consideration of all possible contingencies, will be found to support this conclusion; and (4) that all preventive action must be founded on this theory. We are not prepared to affirm that the disease has not originated, and may not now originate, from conditions and causes other than infection, but we consider the evidence in favour of communicability conclusive, as far as practical effort is concerned. A strong point has been made by some reporters of the escape of some cattle in a village herd or flock, while others, or the majority, were attacked; but the analogy of all communicable diseases proves that liability to attack is by no means universal, and that among numbers exposed there is always an unsusceptible residue: in this disease testimony and experiment prove that animals once attacked are not, as a general rule, again attacked; and, seeing that the disease is so frequent a periodical visitant of all the districts of India, the proportional number of animals thus protected must be considerable. The conditions under which infection operates still remain to be studied. We do not pretend to be able, from the cursory glance we have been compelled to take over an immense field, to indicate all

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these conditions: this must be subject of future observation; but the influence of conditions, such as crowding, cleanliness, season, etc., etc., can only introduce modifications or qualifications of the general law of communicability, which is both fundamental and of primary place and importance.

Season.

One of the most potent of these conditions is, no doubt, season, and on this point the evidence indicates the rainless and hot months as being those in which this murrain most frequently occurs. It follows in this particular human small-pox and cholera, and is amenable, like them, to the repressing effect of heavy and sustained rain. As regards the predisposing effect of breed, age, sex, and condition, the general impression obtained was, that none of these conditions possessed much power in determining or deterring. What the so-called "epidemic constitution or influence" is which provides that in one year or season epidemics or epizootics shall prevail, and in another not so, we are quite unable to say, and, for purposes of action, we are of opinion that communicability and importability should occupy the place of axioms.

Statistics.

31. Numerous figured statements* will be found scattered throughout Appendix No. II, and the more reliable tables have been thrown together in a special Appendix, where their legitimate conclusions as regards the effect of the disease on stock and attacked have been indicated. Most of the tables given have been drawn up rather with a view to exhibit the distribution of murrain, than from any belief in their statistical value. It is, however, convenient, even if exact results cannot be obtained, to express sickness and mortality in terms of figures, and for a single return informing of a complete outbreak, or a first report giving intimation of a new invasion, the form shown on pp. 82-83 (entries 3 to 8) is sufficiently convenient; but where a series of reports—weekly, monthly, etc.—have to be submitted, there is always a doubt as to how the "still ill" have been disposed of; indeed, it could not be improved on, but if different species of disease can be clearly distinguished, they should be shown on separate forms, or as separate entries in one form. It is obvious that exact results obtained in one or a few villages are more valuable for statistical purposes than unreliable data referring to a large area; but, for purposes of general information, figures, even if approximate, give a better idea of how the case stands than records.

Loss by murrain.

As regards the losses of stock incurred through this plague, while exact information is very much wanted, it is evident that the yearly loss, both absolute and relative to number of living stock all over the country, is very serious, and to be counted by hundreds of thousands. Hitherto the actual hardship and inconvenience entailed by it, as regards agricultural operations, have not been anywhere generally felt over a large area, but individuals, or even villages, have often been hampered in agriculture. This was notably the case in Diamond Harbour in 1868. Cattle are still plentiful, cheap, and easily replaced, but as the demand becomes greater, the price still more enhanced, and the number of cattle relative to owners, and requirements fewer, serious hindrance to agricultural operations may be apprehended.

Treatment.

32. The treatment of rinderpest may be considered under the usual heads of curative and preventive. Medical treatment commends itself to the favour of the natives of this country by its facility of application and the absence of interference with their liberty of action; and there is such an inveterate habit with them of taking things as they come, and such a decided aversion to initiating any new course of action, that, though they know the contagious character of the disease, and admit the propriety of segregation, we have found that this measure is seldom

* Not issued.

RINDERPEST.

or never adopted. Attention to animals which exhibit the results of infection is the first thought in a scheme of relief, as the phenomena are patent and excite direct notice; but the conduct dependent on the inferred impalpable phenomena which precede the seizure is not so urgently aroused in the ignorant and unthinking, and is neglected. Thus it happens that the least valuable measure of relief is held in most esteem, and that while men strive to save one life, hundreds are exposed to danger and contract disease. Still, as long as repressive measures are wanting, or imperfect, or ineffective, and while there is ground for believing that a certain line of treatment gives a better chance of saving life than doing nothing, efforts to cure will hold an important place in popular estimation with the natives of this country, and cannot be laid aside.

Medical treatment.

33. The natives in most places confess their powerlessness to treat this disease, and the statement "there is no medicine for *matah*" will be found to be a frequent village confession. When they do attempt any treatment, it is often fanciful or absurd. Feeding with rice gruel or other soft food is the most rational measure they adopt, but even this plan is by no means a general one, and cattle are in most cases left to recover or die with perhaps a few embers smouldering near them, or some absurdity inserted in their nostrils or ears. Fumigation with resin is practised in some places, but this is rare. Worship of the goddess *Shitolah* and sacrifices at her shrine are much more approved remedial measures than drugs or applications, and in some cases the aid of the village *chamar* is invoked to repel some demoniacal influence.

Medical treatment has, however, been largely tried by European cattle owners and veterinary surgeons.

Trials.

The subject of medical treatment has undergone extensive trial at our hands. Many of the cases were hopeless before they were admitted for treatment—moribund, or so emaciated, old, worn-out, and neglected that they soon became so. Such were nearly all the cases brought to us in Assam. The general result of our hospital trials—52·1 per cent. of recoveries and 43·5 per cent. of deaths—is not very encouraging, but taking the circumstances and condition in which our patients were received, and looking at the course of particular cases which were manifestly aided in the progress towards restoration by the means adopted, we are of opinion that the judicious exhibition of medicine and support will save a considerable proportion of animals which would otherwise succumb to the disease. Our conclusions on this subject may be summed up as follows:—

Conclusions. No specific.

I.—No specific has been discovered for this disease and it is difficult, looking at the nature and severity of the lesions discovered after death, to conceive the possibility of doing so. Whether any plan of treatment would avail in the very early stages, in the way of aborting or averting the sequence of future events, is very doubtful. The disease has commenced before it is manifested by symptoms easily apprehended. The early rise in temperature shown by many of our experimental cases proves this, and there is no analogical proved fact to countenance the hope. Besides, practically, few animals can be brought under treatment at an early stage, and there is no warrant for prophylactic treatment of a herd otherwise than by disinfectants, even if such a measure were possible.

Laxatives.

II.—Mild saline laxatives in the early stages are undoubtedly advantageous, but we have found severe purgation positively harmful.

Astringents

III.—Astringents to control excessive action of the bowels are valuable in the eliminative stage of the disease.

O. 551-594.

RINDERPEST. Stimulants.

IV.—Stimulants judiciously given, when exhaustion threatens, often turn the scale in the direction of recovery.

Drenches.

V.—Support by liquid food is essential all through the course of the disease. Thin rice-water (*congi*) is laxative, and it should be mixed with boiled rice, so as to acquire the consistence of gruel. Pease gruel (*kalai*) is more astringent and stimulating, and has been found of great value in cases with a tendency to excessive purging.

Water.

VI.—Water should be sparingly given, and there is sufficient evidence to show that excessive draughts to quench an urgent thirst are a cause of rapid death

Saving of stock.

VII.—If these measures are adopted with judgment, perseverance, and care, we believe that at least 20 per cent. of animals which would otherwise die may be saved.

Preventive treatment.

34. The subject of preventive treatment is, for obvious reasons, a far more important one than medical treatment, and has always had a principal place in the thoughts of those, whether individuals or commissions, who have given the subject attention.

Protection.

35. There are two main alternatives on which it is necessary to decide before entering on a consideration of particular measures, namely, *protection* or *repression*. A scheme of protection rests on the well-ascertained fact that one attack of the disease confers immunity from a second, and its aim is naturally or artificially to provide that cattle shall be so protected. A scheme of repression rests on the contagiousness of the disease, and its aim is to prevent healthy stock being infected by unhealthy,—to stamp out the disease. These ends are entirely opposite, and involve a completely different species of effort and arrangement. It is therefore necessary to decide on one or the other at starting; the only escape from this necessity being a do-nothing policy, or leaving things as they are to abide by the vicissitudes of events.

Opinions.

There can be no doubt of the protective power of one attack of rinderpest. It is the universal belief of the natives everywhere. This is, however, only what obtains in other diseases of the kind, and the exceptions in this case prove the rule. A practical proof of it is shown by the enhanced value of *mantuar* bullocks in Kumaun. It is also indicated by the circumstance mentioned there and elsewhere, that a delay in the recurrence of the disease is a cause of its more virulent manifestation when it does occur. This point was made a subject of experiment at Culna. Animals known to have had one attack of the disease were subjected to the most severe expedients to re-induce it without effect. The protectiveness of one attack may therefore be accepted as an undoubted fact. But the mortality of the disease is equally indubitable, and, even under the most careful treatment, it is doubtful if it can be reduced below 20 per cent. The question comes to be, then—Is at least 20 per cent. of the entire stock of the country to be voluntarily sacrificed in order to secure protection? Here the absence of statistics regarding the effect of the disease on the stock of the country imports hesitation and doubt into the question. It is probable that the mortality among stock from this cause alone does not exceed 5 per cent., if a sufficiently large area be taken. The statistics of particular small murrain-stricken areas during a murrain season cannot be accepted as data in considering this question; and there can be very little doubt that, as far as absolute loss of stock goes, matters are best left as they are, though, were a system of universal induction of disease initiated, the occurrence of the disease would be brought under command, and it would not interfere with the use of cattle, because agriculturists would know what to expect, and would not be

Experiment.

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embarrassed by unexpected loss of cattle during the agricultural season. This consideration is a small one, however, compared with the certain loss of stock. But the question has arisen—Can protection be conferred in any other way? Can the practice of vaccination be imitated, and a trivial non-fatal disease be induced protecting against the serious and fatal one? To this we must reply emphatically in the negative There can be no doubt regarding the inoculability of the disease. We have verified this fact by many cases, but the disease produced by this plan was quite as severe as that caused by natural infection. A large amount of experience has been gained on this point in Russia and elsewhere, and careful and repeated efforts have been made to mitigate the severity of the disease so communicated. A careful summary of all that has been done is given in the "*Report on the Cattle Plague in Great Britain during the years 1865, 1866, and 1867,*" issued by the Veterinary Department of the Privy Council. It is evident that this plan has little to recommend it beside that of voluntarily inducing the disease by exposing animals to infection, except its greater certainty and the result being better in hand. No method of mitigating the disease has hitherto been found, and our experiments would go to show that transmission through sheep does not do so. The Russian Commission found that 15 transmissions through cattle did not mitigate the disease, and the result of their careful inquiries and experiments was that they could not recommend the general introduction of inoculation, but would permit its practice by private individuals under proper precautions and scientific supervision.

Conclusion.

That inoculation, if practised, must be either scrupulously isolated and circumscribed or universally adopted, is evident from the inoculated, disease possessing the same power of propagation that the naturally caused disease has. In truth, inoculating is merely multiplying perils, and the mortality is confessedly never below 5 per cent. in the most favourable circumstances. Apart from the enormous establishment which would be necessary to carry out a universal system, whose cost would far exceed the losses of stock now accruing from rinderpest, it is highly probable that, on the whole, the mortality and inconvenience under a do-nothing system are much less than they would be under a system of general inoculation. A partial system of inoculation, even if the most stringent precautions against propagation of the disease are attempted, must be unhesitatingly condemned, as the necessary establishments and agency would entail greater expenditure than the present loss. Other methods of protection have been tried,—vaccination and the internal administration of disinfectants,—but neither method has been found of any use. The only protective plan of any promise is surrounding sound animals by an atmosphere of antiseptics—sulphurous or carbolic acid. Mr. Crookes' experience indicates that this plan possesses some power in securing cattle against infection, and one of our experiments goes to confirm the truth of this; but while advocating it as a good practice, and an easily employed adjunct to other methods, it is by itself entitled to little reliance, and should not supplant other methods more approved by reason and experience.

Repression.

36. On the whole, a policy of protecting cattle against disease by the present method has nothing in its favour in this country, and all effort must be devoted to repressing the disease and limiting the area of its prevalence and numbers attacked. This is not only the plan recommended by instinct and imperfect knowledge, but that approved by the most careful consideration of the circumstances of the case. All the methods by which a scheme of repression is put in force are passed in careful review in

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the paper already referred to, and while the "stamping out" of the disease should be the constant ultimate aim, its limitation, as regards area and numbers, should be attempted even if "stamping out" is not attainable. The experience which has been gained in Madras would go to show that the simple means adopted in that presidency have been invariably successful in preventing the spread of cattle epizootic disease. Examples of the benefit of measures of this kind are not wanting in this presidency. Many cattle owners of Assam saved their buffaloes by sending them beyond the sphere of prevalence of the murrain. The precautions adopted against the spread of disease in the Andaman Islands clearly saved the stock of the Settlement. The measures adopted on a large scale at Nalla in the Sonthal Parganas evidently quenched the disease. Illustrations might be multiplied and instances adduced of the natives spontaneously adopting measures to isolate and segregate, but the one truth which has everywhere met us is, that precautions of this sort are absolutely neglected, or so imperfectly carried out as to be futile. Murrains are spread through the circumstances of daily life and occupation, and these must be altered or hindered in order to carry out a plan of isolation. Thus, measures intended for a good purpose become a present sacrifice and evil, and it is not strange that a people so short-sighted and little prone to study the future as the natives of India should over-estimate the palpable evils and under-estimate the possible advantages of restrictions. Little can be expected from the people in the way of aid, but much in the way of passive obstruction and neglect of the simplest, precautionary rules. This has necessitated a recourse to law and the police, and persons in authority have had to take forethought for those whose interests are most concerned, and compel them to action in accordance therewith.

Necessity of legislation.

37. The question—Is recourse to law necessary?—has been amply discussed in the papers placed together in Appendix V. The general impression is that without special legislation nothing effective can be done; and this coincides with the experience of Europe, where this belief is emphatically declared by every country in an elaborate and minute code of laws or rules. It is true that though an Act was passed in Madras in 1866, recourse to law was considered, in 1870, neither expedient nor necessary; still the law is there, and though in this country, from the paternal character of the Government and the personal influence which district officers possess, written law is not so necessary as in Europe, the law has a moral force, and sets forth moreover the principles and method which are to guide action. We are of opinion that a law of a permissive kind applicable, as circumstances arise, to particular towns, districts, or divisions, by a notification in the Provincial Gazette, and setting forth what in certain circumstances ought to be done, and may legally be done, should be enacted. It would secure uniformity of action, and would, moreover, arm the Magistrate with a power which, whether actually applied in full force or not, would invest his instructions and efforts with greater influence and effect.

Form of legislation.

38. Taking for granted the need of legal provision, the next question is—What form shall it assume? On this subject the Appendix in question contains much information. The particular points on which we would place the greatest emphasis are,—

Early notice. Agency.

I.—The duty of giving early notice. Unless immediate notice of an outbreak is given, all future action is rendered less efficient. This matter involves the question of what agency is to be responsible for initiating action, whether the owner, the village headman, a special agency—pound-

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keeper, etc.,—or the ordinary police. There is a universal feeling that the existing and convenient agency of the police should not be utilized. The village headman and *panchayat* or his council have been recognized as a sort of village municipality, and if any degree of self-government is possible, this would seem to be the proper village authority in a social matter of this kind; but action embraces an area wider than the village, and the question arises whether the zamindar or his analogue or representative should be the Magistrate's intermediate agent in this matter, or the inspector or sub-inspector of police; or whether a special agency consisting of special district veterinary inspectors and a staff of salutries or pound-keepers shall be entertained, competent to arrange sanitary measures and treat cattle labouring under disease. Whatever may be the ultimate scheme of agency, it is probable that at first existing agency must be utilized, and it would appear to be more reasonable to place on zamindars, their agents and representatives—those paying Government for the rent of their land—the onus of carrying out means to save their own and their neighbour's cattle from disease. Such a scheme would involve an immediate notice of outbreak by owners to the village headman or zamindar's representative in the village or town. In places with municipalities, the municipality and its agents would be the responsible agency.

Segregation.

II.—The duty of prompt segregation would naturally attach in the first place to owners, who should be compelled to isolate their own sick and segregate their healthy. How this is to be done is a problem not easy to solve. The reason universally alleged for failing to segregate was want of suitable arrangements, and in the more densely peopled and largely cultivated districts the question is not an easy one. The stock of an owner might be isolated for the time in his house, but this in seasons of cultivation would impose on him hardship and loss, and without possessing a separate special cow-house he could not segregate; besides, his compound would be too small to provide sufficient distance, his healthy stock would be exposed to the contamination which had already taken place in his byre, and, moreover, he would have still to tend, them all, and would convey infection from the sick to the healthy. Special village arrangements are therefore clearly indicated—a plot of ground, held in common, available for strict and absolute segregation of sick under a special cowherd, where a temporary shed might be erected, and to carry out with any effect a system of sanitary treatment, the cow house would have to be abandoned and thoroughly disinfected, and the healthy stock, containing perhaps infected animals, placed in isolation elsewhere. This would involve some permanent well known rule, common interest, a certain amount of common action and sacrifice, an agency responsible for its adoption, and a common penalty for neglect. The village would have to be isolated and proclaimed, all intermixture of cattle with those of other places interdicted, and the precautions initiated maintained until some weeks after the last case. The power of modifying this rule during the agricultural season, in strict consistency with rigid segregation, would rest with the local authority. The difficulty of the problem increases as the affected area is wider, and when a large area is infected general stoppages of movements, regulation of

Early action.

fairs, etc., would have to be ordered by the Magistrate on a large scale, and in such a case the services of the general police must be brought into requisition. It is thus imperative that, for economy of effort, and with a view to minimise irksome restrictions, the earliest notice of outbreaks, and the adoption of proper measures when the disease presents the smallest proportions, should be one of the principal objects. To ensure this, the people must be practically taught segregation, and the plan most approved by experience installed as a village habit.

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III.—When circumstances admit of it, there can be no doubt of the superiority of the plan of removing the healthy and isolating the sick, rather than simply removing the sick for isolation. The Madras system of kraaling is undoubtedly the best possible in the country, but it demands space. In some districts and parts of districts it is possible, but in others not so, and the possibility of it should be made matter of distinct investigation and provision in every district and locality. — **Removal of healthy.**

IV.—The treatment of the isolated sick should be carefully carried out and either the people instructed in simple methods of doing so, or special agents made available for the purpose. — **Treatment of sick.**

V.—All things considered, the burial of carcasses is the best method of their disposal, and this might be done by the chamars, who might in consideration be permitted to take the hide, provided they soaked it thoroughly, and at once, in lime water, or salt and water, under supervision, and *on the spot*; otherwise it should be scored and buried with the carcass. The exhumation of the carcasses by dogs and jackals or wolves, or by chamars, might be provided against by sufficiently deep burial in the one case, and scoring the hide in the other; the responsibility of this measure would rest with the village headman, aided by the chaukidar. — **Burial of carcasses.**

VI.—Disinfection, in the full sense of the term, would have to be carefully carried out all through, but fire is obviously the most effective and suitable. — **Disinfection.**

VII.—The more serious, though efficient, expedient of killing is so antagonistic to the feelings of the people of India that we do not recommend its adoption in any case, even if the circumstances of the disease, as it prevails in this country—so common, so frequent, and so scattered—did not preclude its adoption. — **Killing.**

39. Though we feel that the subject is hedged round with practical difficulties, we deem it our duty to submit a particular plan, and we accordingly recommend that one or more skilled agents be attached to each Collectorate for employment for the suppression of cattle plague; that a rinderpest quarantine plot be definitely assigned to every village or a group of villages, where the sick may be promptly segregated. It might be used for pasture during plague-free times, but on the appearance of plague should be fenced in and employed as a hospital, and kept fenced in and vacant for some time after cessation of plague. Such temporary hospitals constructed of bamboo and grass, might be put up by the villagers at short notice, and would be burnt when no longer required. It would be the duty of the owner, under penalty, to report to the village headman the outbreak of disease; his duty, with the chaukidar's aid, to insist on isolation and the construction of the temporary hospital, and to adopt preliminary measures as above sketched. If the disease spread beyond one or two cases, it would be his duty to report to the zamindar or his agent, who would immediately see that the required measures have been adopted, and would report to the Magistrate, who would despatch his veterinary inspector or other agent to direct the carrying out of effective measures and treat the sick. The general ideas of segregation and destruction of contagium must govern every particular measure devised. Simpler plans would have to be adopted at first, and when their advantage became evident and the system familiar, there would be less difficulty in insisting on more stringent measures. We would advocate the legalising of the most extensive, severe, and stringent measures for adoption when the necessity arises, but as the kind and extent of measures used must depend on the circumstances and needs of the case, we would bar the adoption of any but the — **Proposed scheme.**

OXEN.	Selections from Report of Indian Cattle

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most simple measures of a preliminary kind until, on full cause and occasion being shown, the local Government authorised publicly their adoption.

Veterinary education.

40. There is one subject, however, which we would press upon the early attention of Government, namely, veterinary education. Our pages show what a lamentable yearly loss of stock there is throughout India; how much of that is owing to neglect and ignorance; how crude and erroneous are the notions generally entertained regarding the hygienic treatment of stock, their diseases, and their treatment, hygienic and medical; and there is a real and pressing demand for the diffusion of sound knowledge on all these points.

Circulars and simple manuals translated into the vernacular are very good as far as they go, but it is doubtful whether they command much attention practically, or penetrate, to any material extent, beneath the crust of apathy which surrounds the average cattle owner. What is wanted is a skilled agency, and this can only be attained by means of systematic instruction imparted in an organised school where precept is illustrated and impressed by practice. It is not too much to anticipate that the wealther among a people, whose lives depend on their cattle, and who entertain such extravagant ideas regarding their care, nay, their sanctity, will rejoice to have an opportunity of coming forward and associating their names with so congenial and pious a scheme by endowing an institution of this kind.

Properly organized, it would be available for the instruction as well of all persons who may have the care of public stock—horses and cattle; of a native agency by which epizootic and other diseases might be properly investigated and treated, and of a class who might devote themselves to the private practice of the veterinary art.

Affection of other animals than cattle.

41. Another point to which our attention was always directed was the susceptibility of other animals to rinderpest. On this point the evidence is ample, but very contradictory, and its solution not only interesting, as bearing on the scientific question of what different species of animals are liable to attack by one specific disease, but important with regard to the conveyance and multiplication of contagium and measures of prevention. That bullocks, buffaloes, yaks, jooboos, goats, sheep, and deer are liable to infection, is beyond doubt. The evidence is strong as regards pigs, but we failed to induce the disease in them by inoculation; as regards dogs, jackals, wolves, cats, tigers, and horses, the allegations made are subject to very considerable doubt. There can be no doubt that fowls are liable to an eruptive febrile affection, and in the case of the village of Akna we found this co-existing with rinderpest, but we failed to induce any disease by inoculation. Carrion animals are, however, an undoubted means of spreading the disease, and it is probable that even flies may convey the contagium from one subject to another; the practical rule of preventing access of all living creatures to the diseased or dead is therefore well founded, and the considerations now adduced furnish another strong reason for the burial of carcasses.

Carrion animals.

Resumé.

42. It will be convenient, before closing this general sketch of the results of our inquiry, to recapitulate the principal recommendations which we have been induced to make. They are as follows:—

I.—Whenever murrain breaks out, it should be made a subject of special local inquiry by committees or skilled agents.

II.—In order to test the effect of epizootics upon stock, an accurate census before and after the outbreak is absolutely necessary; or, if this is not attainable, an approximate census of the cattle of districts should be

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made to serve as a basis upon which the extent of loss from any outbreak may be estimated.

III.—As a means of exhibiting the fluctuations of value of stock, market prices of different kinds of stock should be periodically published in local Gazettes.

IV.—The systematic storing of fodder and jealous preservation of pasture land, where it exists, and its provision where it does not exist, are important considerations as regards the welfare of stock generally.

V.—Herding and droving cattle should be watched and regulated, especially in times of murrain.

VI.—Large fairs should be subject to skilled inspection and sanitary precaution, and smaller fairs carefully watched, especially in murrain times.

VII.—The hide trade is a source of danger, and should be watched and regulated. In times of murrain, hides should be destroyed or thoroughly disinfected.

VIII.—A law should be enacted for India regulating and restricting the sale of poisons.

IX.—Slaughter-houses should be under skilled supervision.

X.—Government cattle should, if possible, be placed under the veterinary charge of skilled men.

XI.—A law should be enacted embodying rules for the repression, and prevention of spread, of murrain, and capable of ready application to any locality when the necessity arises.

XII.—A veterinary school for the training of a native skilled agency should be organised.

XIII.—Such skilled agents should be attached to municipalities and collectorates to investigate and report on murrains, and apply preventive and remedial measures.

XIV.—A yearly summary of all the information which has been collected during the year regarding cattle murrains should be prepared and published, and the subject should constitute a point of attention in administration reports of provinces.

XV.—The collection of such information and preparation of such reports should be assigned as a duty to some particular individual, office or department.

Acknowledgments.

48.—It only remains for us now to express our sense of the unfailing courtesy and ready help which we always experienced at the hands of district officials in the prosecution of our inquiries, and of regret that from circumstances beyond our power, we have not been able to present this report sooner.

PRESIDENCY DIVISION.

Historical Sketch.

PRESIDENCY DIVISION. Historical Sketch.

Cattle murrain attracted the attention of professional men more early and more strongly in Calcutta than elsewhere in Bengal, and though records and recollection do not extend its history back beyond one century, still we have in the work of Dr. Duncan Stewart, Superintendent General of Vaccination, "*On Small-pox in Calcutta,*" published in the year 1844, a chapter on "the disease among cows," which contains a most valuable and systematic description of murrain, then, as now breaking out in the dairies of Calcutta every year or two, and sweeping off numbers of dairy stock. The circumstances of Dr. Stewart's inquiry have been repeated all over Bengal. Whenever attention has been directed to the diseases of horned stock, murrain has been *found* carrying off hundreds of cattle, or has been ascertained to have recently done so,

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and the natives have with one voice declared that this is nothing new—has been told them by their fathers and grandfathers—has indeed become such a feature of rural life that it occasions neither surprise nor complaint. Wherever the Cattle Plague Commission has gone in the prosecution of these inquiries, this experience has been faithfully reproduced until the general belief has grown strong, without reasonable doubt, that, over the length and breadth of Bengal cattle murrain has *always* prevailed as it now prevails, quietly stealing from village to village, killing cattle by scores in each, and in some seasons of exceptional insalubrity—a drought, a flood, or a cyclone—producing such wholesale havoc and death that agricultural industry is for the time paralysed, and it needs a season or two of prosperity to repair the damage. The primary object of his investigation was to find a case of natural cow-pox for the purpose of obtaining an indigenous source of supply of vaccine lymph. This same object led to the discovery and description of cattle disease in Hooghly, Murshidabad, Sylhet, Saugor, and elsewhere, but the subject of the discovered disease was not in any other case so carefully followed up for its own sake as by Dr. Stewart. This gentleman with an admirable scientific instinct originated a very complete inquiry. He visited the Calcutta byres and personally studied the symptoms and pathology of the disease; he carefully questioned those most likely to know, as to the history and features of the plague, and had a searching inspection of the Calcutta slaughter-houses and meat markets made. The results of these steps will be found in the extract.

1795-96. The earliest recorded date of any particular murrain is 1795. In that and the following year, according to Mr. Blacquiere, one of Dr. Stewart's informants, a great mortality occurred among men and cattle in the months of January and February. Another informant, Mr. John Tell, a hide merchant and tanner, was familiar with the disease *Matah*,

1828-36. and wrote of its general prevalence in spring. In 1836 Mr. H. Piddington, whose name and repute as a careful and correct observer are so well known in connection with the subject of cyclones, wrote in the *Transactions of the Agricultural and Horticultural Society* (*Vol III, page 126*) an account of "the *basanta* which attacks the cattle of Bengal." He surmises that the disease is a species of dysentery, states that his own cattle were attacked three or four times in the course of seven or eight years, gives a slight sketch of the symptoms, and details a method of treatment (fumigating with muriatic acid fumes) which he recommends with confidence.

1843-44. This interesting paper leaves no doubt as to the identity of the disease or its frequent prevalence. The outbreak of 1843-44 was a very severe one. It commenced in September 1843 and lasted till June 1844, attaining a maximum in January. The table at page 42 of this appendix shows the very remarkable parallel which obtained between this epizootic and the epidemic small-pox which simultaneously prevailed. The recorded mortality is 2,233. Dr. Stewart's description of the symptoms of *Matah* leaves no doubt that the disease was rinderpest. His attempts to discover natural vaccinia, perseveringly carried on for 15 years, were a complete failure, and he was equally unsuccessful in his endeavours to variolate cows, and by this means to obtain an Indian source of lymph protective against small-pox. It is remarkable that though the variolation of cows has been tried over and over again in India, no satisfactory results have ever been obtained.

The subject of cattle murrain at the Presidency is now lost sight of until 1864, when two circumstances aroused fresh interest in it. The first was a communication from the Government of Madras, regarding

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cattle disease which prevailed in Karnul in 1863, drawing attention to the subject and asking for information. The second and most effective cause of renewed attention was the breaking out of murrain at the exhibition held under the auspices of the late Lieutenant-Governor of Bengal, Sir Cecil Beadon, at Belvedere in 1864. Then, as in 1844, inquiry revealed the frequent prevalence of epizootics, but the inquiry was now conducted on a more extensive scale, and embraced the whole of Lower Bengal, in each *district and division* of which murrain was found to be a subject familiar to the people and a frequent visitant. The interest in the matter spread from Madras to Bombay and Burmah, and from Bengal to the North Western Provinces, Oudh, and the Punjab, and more recently to the Central Provinces, the result everywhere being the same. Still later the English cattle-plague and the identification of the Indian plague with rinderpest, which was made by Dr. Murchison at Home and by Dr. Palmer and others in India, kept this interest alive; the appointment of the Cattle Plague Commission still further stimulated inquiry, and facts have latterly been pouring in from all parts of the country. This will explain the peculiarity observable in all these sketches of the history of the disease, namely, that cattle murrain has been apparently more prevalent and virulent during later than earlier.

As regards Calcutta, it was ascertained that in 1861 "gutí" prevailed so violently among the municipal cattle that the services of a veterinary surgeon were considered necessary, and that in 1862 and 1863 frequent outbreaks occurred in its neighbourhood. The outbreaks recorded were those which happened among the cattle of gentlemen and men of substance, who bred stock for pleasure or fancy, but the deaths which must have been taking place among the cattle of ryots and gwalas were not brought to light. The evidence of Mr. Taylor (page 75) shows that as early as 1857 the cattle of the Municipality were severely attacked by "gutí," which has since then prevailed among them almost yearly. 1857. 1861-62-63.

Dr. C. Palmer was now appointed by the Government of Bengal to report on the whole subject, and this officer has given us a most valuable description of the disease as observed by himself and the veterinary surgeons of Calcutta, more particularly Messrs. Greenhill and Rutherford at the Exhibition, and a valuable summary of the observations of district officers throughout Bengal. He showed to demonstration that the "Calcutta epizootic" was nothing other than rinderpest, but was in error in supposing that the "gutí" or "matah" reported from the districts was "epizootic aphtha"—foot and mouth disease. 1864.

This report has been printed in a volume of selections of "papers relating to cattle disease," which has been extensively circulated (pages 74-104).

As regards the other districts of the Presidency Division, the Commissioner, Mr. Dampier, states generally that "the cattle murrain described by Captain Nelson (Karnul, Madras) appears to be well known in this division," and this statement is abundantly supported by the reports of district officials in Nuddea and Jessore and their sub-divisions. The oral testimony of the people, communicated to the Commission, and of district officials, leaves no doubt as to the frequent prevalence of *basanto* or rinderpest, *puschima*, which is applied to severe forms of rinderpest and to hoven—a disease arising from eating unwholesome food, as well as *khura*, or foot and mouth disease.

The next murrain which attracted any notice in this division was in the Satkíra sub-division of the 24-Parganas district, in the cold weather of 1865. This murrain was *basanto*, and continued to prevail in 1866. In March and April of this year, this disease is said to have 1865-66.

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caused great devastation among the cattle of several villages adjoining the Sundarbans. The same form of disease (rinderpest) prevailed in Jenidah and Bagirhaut sub-divisions of the Jessore district In the latter the loss of cattle was estimated at 1,200 head, and pigs, deer, and buffaloes died in great numbers during, and apparently of, the murrain.

1867. The plague continued to prevail in Jessore in 1867, and in July of that year Dr. K. McLeod, then Civil Surgeon of the district, personally investigated it in the sub-division of Khulna. It was found to be committing considerable havoc among the cattle of the agriculturists, and the description of the symptoms and *post-mortem* appearances leaves no doubt that the disease was rinderpest. This year was signalized in these parts by an unusually high inundation, and on its subsidence a virulent murrain broke out in the district of Nuddea. A swelling of the throat and neck, and wasting, are noted by the Collector, Mr. H. Bell, as the most prominent symptoms of the disease, which appears to have been owing to the cattle eating submerged grass; but in the absence of a description by a skilled observer, it is difficult to pronounce decidedly on the type of this disease. It appears to have subsided towards the close of the year

1868. In 1868 a very serious and severe outbreak of rinderpest occurred in the Diamond Harbour sub-division of the 24-Parganas district. This murrain has been carefully described by Baboo Hem Chunder Kerr, Deputy Collector, who was during that time in charge of the sub-division, and by Mr. H. Farrell, V.S., who was deputed in August to visit the affected tract and adopt measures, preventive and remedial, suited to the emergency.

The disease appeared in January 1868 in the village of Bansburia, into which it was supposed to have been imported by bullocks bought at the Ulubaria fair. From this place it spread southerly and westerly all over the sub-division, attained its maximum in July and August, and abated in October and November. The mortality from this outbreak is put down by the Deputy Magistrate at 26,151 head of cattle. This was ascertained as the result of a special inquiry. The losses entailed on the agricultural classes were most severely felt, and notwithstanding the remarkable energy displayed by them in striving again and again to replace their losses, the sub-divisional officer states that "a good one-fourth portion of the paddy lands remained untilled for want of cattle." The severity of this outbreak seems to have been enhanced by an unusually heavy rainfall and by the exceptionally high inundation of 1867.

1869. Mr. Farrell's services were in 1869 employed in Jessore, in which district rinderpest prevailed to a severe degree. The plague was most virulent in the sub-divisions of Magura (to the east) and Khulna (to the south). There was also an outbreak at the Satkira sub-division of the 24-Parganas district in the commencement of the year. In the Diamond Harbour sub-division of the same district, rinderpest continued to prevail to a more limited extent, and towards the close of the year began to appear in villages of the Chuadanga sub-division of the Nuddea district. Here the murrain continued to spread, and attained a maximum in February and March 1870.

1870. This district was visited by the Cattle Plague Commission, who established their head-quarters at Chuadanga, and from the 4th to the 25th March studied the nature, symptoms, and treatment of the disease. Rinderpest of a comparatively mild type was found to prevail in most of the villages of the sub-division, and much interesting information as to the past history of this disease, the condition of agricultural stock, etc., was elicited from the people. Cattle disease prevailed to a slighter

PRESIDENCY DIVISION.
Historical Sketch.

extent in the Ranaghát and Bongong sub-divisions, and was subsequently reported to have subsided throughout the district in April. Rinderpest was found to prevail to a great extent in March in the Calcutta milkmen's sheds, and evidence was abundantly obtained to the effect that frequently, or yearly, great losses of dairy and other stock from rinderpest occurred. There was a smart outbreak of this disease in some villages of the Baraset sub-division in March and April; in the Satkira sub-division slight outbreaks arose from February to June, and throughout the year partial outbreaks occurred in a scattered manner in the sub-division of Diamond Harbour.

From Jessore, also, occasional reports were forwarded of limited visitations in the Jessore, Magura, and Bagirhaut sub-divisions, but nowhere, except at Chuadanga, did any widespread epizootic or serious loss of cattle occur.

Still later—in November and December—cases of "*guti*" were reported to occur in villages of the Khustea, Chuadanga, and Ranaghát sub-divisions of Nuddea, but the disease was scattered and its mortality slight.

ORISSA DIVISION.

No early record of murrain in this division exists, and until the year 1864 no attention appears to have been bestowed on the subject.

1863.

Disease is said to have "raged fearfully" in 1863 in the Tributary Mehals running west of Cuttack to a distance of 150 miles, and more than half of the cattle in the *killahs* (forts) south of the river Mahanadi are said to have been lost. An epizootic occurred in 1864 in the district of Balasore, where the disease *guti* or *basanto* (rinderpest) was said to be "well known," and to prevail every two or three years and commit great ravages. The characteristic symptoms of the disease are described by Dr. N. Jackson, the Civil Surgeon.

1864.

Murrain is stated by the Commissioner, R. N. Shore, Esq., to have "shown itself very extensively" in the districts of Purí and Balasore in the same year. The Collector of Purí estimates that the stock of cattle in his district has been diminished one-half.

1866.

Up to 1869 no general outbreak of disease is reported, with the exception of an attack of foot and mouth disease, which occurred in 1866 among the artillery cattle in the station of Cuttack. A letter was sent on the subject to the Bengal Government by the Commissioner, T. E. Ravenshaw, Esq, in November 1866, which states explicitly that, with the exception above noted, there was no instance of the recurrence of the disease since 1864.

1868.

Another notice of rinderpest among the artillery cattle at Cuttack is contained in one of Mr. Thacker's Madras Reports, dated 31st March 1869. He says:—

"A telegram from the Commissary General on 18th November 1868 informed me that artillery cattle at Cuttack were dying from 'diarrhœa and fever combined.' He requested me to forward instructions to the officer commanding relative to treatment and medicines if necessary. Believing that this was an outbreak of rinderpest, I at once forwarded instructions for segregation and despatched medicine, the successful results of which will be seen in the following letter from the officer commanding:—

"With regard to preventive measures of segregation, I have to report a complete success. Your letter was received on the 29th November, and in a day or two afterwards the bullocks were divided as recommended by you. After the separation of the cattle, one bullock only was taken ill and died in a few days. Since this bullock was taken ill no other animal has shown any signs of disease whatever, and all those in detached parties have remained up to this time in a perfectly healthy condition."

1869.

Towards the close of the year 1869 disease broke out in the districts of Cuttack and Purí, and continued into 1870.

OXEN.	Selections from Report of Indian Cattle

ORISSA DIVISION. Historical Sketch.

In the former district the nature of the disease was not described, and was reported to be prevalent in nine villages of the Bargong Pargana. Later reports show the prevalence of "cattle-pox" in September 1870 in seven villages of the Ramito and Utikun Parganas on the banks of the Nuna river.

1870.

In Purí the disease was more widely spread and invaded several villages of five parganas. Both rinderpest and foot and mouth disease appear to have prevailed simultaneously.

In this district also a September outbreak is described in twenty-six villages of the Pargana Kodhar and Thannah Gope. A later report, dated 13th October, describes the prevalence of foot and mouth disease in some villages of Pargana Kotdesh. Balasore is reported to have been free from disease in 1870.

It thus appears that both rinderpest (called *thakruni*, *basanto* or *gutí*) and foot and mouth disease (called *phatua* and *chowa*, according as it prominently affects the feet or month) frequently prevail in the districts of this Division, more particularly, it would seem from information casually obtained, in the breeding tracts on the Orissa seaboard and at the base of the hills. Orissa is one of the great breeding grounds of Lower Bengal for cattle, and on this account the disease has not perhaps obtained in this Division the attention it deserves. No sufficiently urgent or exact information of existing disease was received by the Commission to warrant a journey both long and expensive. The reports forwarded detail the symptoms of both diseases with sufficient precision to leave no doubt as to their identity, but they do not offer any further information which would render their publication desirable. They are therefore omitted.

DACCA DIVISION.

A very important and curious glimpse of an early history of cattle disease in this Division is obtained through the results of an effort made by the Medical Department to obtain vaccine lymph primarily from the cow. The details of the experiments, correspondence, etc., in this matter are in part contained in the "Transactions of the Medical and Physical Society of Calcutta," Vol. VIII, Part 2, pp. 94-106 of Appendix.

As the Sylhet experiments have a very interesting relation to the subject of the present inquiry, the following summary of these observations and experiments has been made :—

1833.

Dr. Furnell, Civil Surgeon of Sylhet, having read and become interested in Dr. Macpherson's experiments at Murshidabad (see Rajshahye Division) in September 1833, endeavoured to repeat them. He found that cattle in the vicinity were affected with *matah*, and selected one recovering, which had a number of dry scabs all over its body. Four children were inoculated from this animal without effect. Mr. Brown in Dr. Furnell's absence renewed the trial and inoculated several children, the first four direct from the cow, and many others from these. The vaccine vesicle appeared on the eighth day in all cases. One European child got severe fever on the eighth day, succeeded by an eruption resembling confluent small-pox, which ran through apparently the same course as natural small-pox. In the case of his own child a similar event occurred, but with a fatal result, the mouth becoming so sore that no nourishment would be taken. Another European child suffered severely in a similar manner; but none of the native children inoculated presented any alarming symptoms, and the utmost precautions were taken to exclude variolous infection. The disease is also stated to have prevailed among the cattle of Cachar at the same time. Owing to the result of these trials being so unsatisfactory, no further experiments were made on this subject.

DACCA DIVISION.

Historical Sketch.

A very interesting notice of *basanto* by Mr. Lamb, Civil Surgeon of Dacca, is contained in a letter addressed to the Superintending Surgeon of his Circle, on the subject of the regeneration of vaccine. The following is an extract referring to cattle disease, from which it appears that the same disease prevailed in the same manner then as now:—

"The disease among cattle, known under the appellation of *basanto* or *matah*, *sitlah* or *guti*, chiefly prevails during the months of December, January and February, though not quite unknown at other seasons of the year. When a cow or bullock is first attacked, there is a discharge of saliva from the mouth; then follows universal tremor, with great heat of the head, chest, and body, as far back as the loins; while the hind quarters are cold. The whole body then becomes hot, and the animal suffers from intense thirst, the flow of saliva ceases, and the mouth becomes dry and hot. After the fever has existed a day or two, the hair becomes so loosely attached, that the slightest rubbing brings it off in handfuls. On the fifth day the eruption appears about the udders, sometimes only a few pustules, at other times they are numerous and confluent; but the result does not seem much dependent on the eruption. Whether the pustules are numerous or rare, the disease is almost equally fatal, and unless measures are taken to separate the infected from the healthy, it speedily runs through the whole herd, sparing few. In those which do escape after taking the infection, the favourable symptom is a spontaneous diarrhœa, in which the dejections are large, watery, and offensive. The treatment is sometimes guided by this indication afforded by nature, and a variety of vegetable purgatives are employed, but more generally is limited to absurd mummery and fanciful magical incantations. 1836.

"When the hair is rubbed off after the pustules have appeared on the udder, the skin is found covered with sores; many die before the eruption makes its appearance, but the fever is known by the discharge of saliva, by the falling off of the hair, and loosening of the teeth. In favourable cases, three or four days after the eruption has come out, the teeth acquire firmness in the gums, and the animal is able to pick up a little grass. Cattle are said not to be subject to a second attack of *matah*; sometimes the disease is exceedingly fatal, at other times it is comparatively slight without much reference to season or apparent cause; it is, however, at all times greatly dreaded, and with reason, as it is too often the cause of utter ruin to villagers whose whole wealth is in their cattle. I have been unable to discover instances of its frequent co-existence with small-pox among the natives, and the disease is little known in town. Among the cattle kept by the oil manufacturers or for milk last year, when nearly a thousand deaths from small-pox occurred in Dacca, the disease only appeared in one muhalla, and for a short period; and I was not aware of its presence till it had ceased, after carrying off fifteen or twenty cows."

During a period of 24 years (1836-60) no written record of cattle murrain has been furnished from this Division.

Dr. Brown, Civil Assistant Surgeon, Sylhet, informs the Commissioner in 1863 that a cattle murrain prevailed in the district in 1860, but that since then no cattle disease has appeared: the symptoms detailed are distinctive of rinderpest. 1860.

Captain J. F. Sherer writes, in December 1863, that no cattle murrain has ever existed in Cachar; but it will be noted that Mr. Brown states that murrain prevailed in Cachar in 1833. 1863.

Mr. C. T. Buckland reports on cattle diseases as known in the different districts of the Dacca Division in 1864. He quotes Dr. Bholanath Bose, of Faridpur, who states that "the disease is well known in Bengal," and that "there is hardly a year in which one does not hear of some cattle mortality during the hot weather from this source." Dr. Bose is reporting on the rinderpest described by Captain Nelson in Madras (8th July 1863). Mr. A. T. Maclean, Officiating Magistrate of Mymensing (5th March 1864), states that disease somewhat resembling that described by Captain Nelson yearly attacks cattle in Bengal, at the change from the cold to the warm weather. The disease is similar to small-pox in man and is called *basanto*. It is described as destroying thousands of cattle. 1864.

OXEN. | **Selections from Report of Indian Cattle**

DACCA DIVISION.

Historical Sketch.

1865. In 1865 a very severe and fatal outbreak occurred in the district of Backergunge. The disease was imported from the adjoining district of Jessore across the Balissur river. It is reported to have raged in several villages on the Jessore side of the river in February 1865, and appeared in the Perozepur Sub-division in April. The disease spread over the Tugrah, Angaria, and Bishkhalf Thana jurisdictions, and continued to rage till September, when it seems to have declined. The mortality in the whole district is estimated by the Magistrate, Mr. Sutherland, at 30,000 to 40,000. In the Sub-division of Perozepur alone, 14,399 head died, of which 13,199 are said to have died in the Tagra Thana. Mr. Sutherland observes that the loss by murrain has "brought ruin to thousands of ryots." From the careful detail of symptoms given by the Civil Surgeon Mr. Bensley, it is evident that this murrain was rinderpest.

1866. In 1866, Dr. Brown, of Sylhet, was informed by a European gentleman that the disease was common about 70 miles to the south of the district. Mr. F. B. Simson, Commissioner of Dacca, reports (26th August 1869) that in 1866 a fatal murrain occurred among the cattle of Mymensing in July and August.

1869. An equally fatal murrain broke out in this district in the same months of 1869. In March 1869 cattle disease broke out in the Abidabad Police Station of the Sylhet District, and in September and October in Mulagul, Noakhal, Tajpur, Chattuck, Lawur, and Shonamganj Thanas, and out of 42,000 attacked, 13,700 are said to have died. The disease seems to have continued to rage in this district up to May 1870, and a subsequent report in November 1870 states that disease was still prevailing in the district. In the district of Mymensing, disease broke out in September 1869 and continued to rage till January 1870. A slight outbreak was again reported by Mr. Simson, in the Pingna Pargana, in November 1870.

1869. In the Dacca District "small-pox" is reported to have broken out in the Thanas Raipur and Rupganj about April and May 1869, and in the Thana Manickganj in March.

1870. In March 1870 the disease is reported to have prevailed in the same locality.

BURDWAN DIVISION.

1836. Prior to the year 1864 cattle disease did not excite any attention in this Division, and no records of outbreaks exist, with the exception of a report on *matah* or *guti* forwarded in 1836 to the Medical Board at Calcutta by Dr. T. Wise, Civil Assistant Surgeon of Hooghly. This report was elicited by circulars issued by the Medical Board in 1834 and 1836, the first desiring information as to the existence of natural vaccinia in India, and the second regarding the "small-pox" among cattle, to which, in the interval, the attention of the Board had been directed. These circulars, which are of considerable historical interest, are printed in the appendix, and the replies to them from other stations will be alluded to in the proper place. These have been transcribed, by the permission of the Inspector General of Hospitals, from the valuable records of the Bengal Medical Department.

The Districts of Hooghly and Burdwan were visited by the Commission in April 1870, and the oral testimony obtained was to the effect that the disease called *guti* or *basanto* (rinderpest) has prevailed from time immemorial, and breaks out in particular places at frequent intervals. This is, no doubt, true of all the districts, and it is doubtful that in any year the whole of any district is free from this disease or from *khura* (foot and mouth disease). The Commissioner of Burdwan, O. F. Montresor, Esq., writing in February 1864, states that "all the districts of this Division have suffered more or less from this disease." In Birbhum it was prevalent during the Santhal insurrection (1855), and existed in some

BURDWAN DIVISION.

Historical Sketch.

places at the time the letter was written. In Bancoorah it had been virulent four years previously; in Burdwan had been known for 20 or 30 years; in Midnapur was reported to be a very common disease; in Howrah broke out every three or four years, and in a subsequent letter, dated 1st November 1860, the Commissioner (R. P. Jenkins, Esq.), on the authority of Baboo Joykissen Mookerjee, an influential zamindar, states that *guti* is very well known in the district, and appears every year at the commencement of the hot weather. One reporter, Mr. Sawers, avers that the natives of Culna assert that the disease was introduced from the North-West by the bullocks of cartmen, 25 or 30 years ago, and was then (December 1863) a resident and established epidemic of the district. The inquiries of the Commission would go to show that this belief is unfounded, and that no date can be assigned to the importation of murrain into Burdwan; and this is probably true of every other district in India, though there is a universal tendency in the people of one district to ascribe the origin of cattle disease to some other. Statements that the disease originally came from the north, south, east and west are exceedingly common.

Written records of particular outbreaks are as follows, oral testimony being disregarded as vague :—

Cattle disease is said to have been very virulent in Bankura, but the particular localities affected are not mentioned. **1860.**

Disease is said to have prevailed in the Sub-division of Culna virulently in 1862 and in a milder form in 1863. Mr. Stalkartt gives instances of its prevalence at Howrah and in the neighbourhood of Calcutta in both these years. **1862. 1863.**

All the districts of the Division are said to have suffered more or less in 1864; but in Bírbhum disease prevailed in the Parganas Nagar, Shaculfpur, and Mouressur. *Guti* is said to have prevailed in this district during the years 1865-66, and the mortality of the disease is put down at 4,500. **1864. 1865. 1866.**

The particular localities visited are not mentioned. Disease also prevailed in the Sub-division of Gurbettah, Midnapur District, in the latter year. In a report dated 6th January 1870, the Magistrate of Bankura states that the disease has existed in a mild form during the last three years. **1867. 1868.**

Towards the end of 1869, however, this district appears to have been visited severely, and the outbreak which commenced then continued to prevail widely during the first seven months of 1870. A detailed statement was called for from each Thana in the district, which showed that only three of twelve police stations gave a clean bill of health. In the remaining nine, a considerable mortality had occurred up to the month of July 1870, giving a total of 11,045 deaths for the district. The principal cause of this mortality was *basanta* (rinderpest), but *khura* (foot and mouth disease) and others prevailed simultaneously. **1869. 1870.**

Similarly, in the District of Burdwan a very general outbreak of murrain made its appearance in November and December 1869, prevailing over the Sub-divisions of Burdwan, Bood-Bood, and Cutwa. This seems to have become intensified, and spread during the first six months of the year; and though in July the disease had greatly abated, and in most of the villages where it had prevailed altogether subsided, it continued to prevail here and there in different places, and as the rains cleared off came to be heard of more frequently.

In Hooghly also rinderpest prevailed very extensively. Reports were received at intervals from January to September, showing that the disease prevailed in several villages of the following police stations, *viz.*, Goghat,

OXEN.	Selections from Report of Indian Cattle

BURDWAN DIVISION.

Historical Sketch.

Bashbarea, Bidyabatí, Haripal, Kkanakul, Chandítola, and Jehanabad.

In Midnapur a severe outbreak of disease occurred in June and July in the Sub-division of Tumlook, but the remaining portions of the District seem to have remained unaffected. From Bírbhum a report was received in January, stating that *basanto* and *khura* prevailed in the south-eastern parts of the district, but nowhere else.

Towards the close of the year reports of murrain from the Burdwan District became more frequent. The disease prevailed to a small extent and in a scattered way in the Bood-Bood Sub-division, more severely in the Gangooria and Munglecote stations, south and north of Burdwan; and latterly an hospital for treatment was opened in the town of Culna, east of Burdwan, where numerous cases were obtained from the town and neighbouring villages. The Tumlook outbreak was reported on the 26th of October to have disappeared. In Hooghly, reports were received in November of the prevalence of disease at Chínamur, but the cases were scattered and few.

Bankura and Bírbhum appear to have continued free of plague throughout the rest of the year, no reports having been received subsequent to those above referred to.

CHOTA NAGPUR DIVISION.

1836. A very interesting account of *matah* among cattle in this Division was elicited by the Medical Board in 1836. The account of it, written by Assistant Surgeon W. Dunbar, shows that then, as now, an equally destructive murrain, apparently of the same nature, every two or three year ravaged the cattle of these districts.

Recent inquiry regarding the prevalence of cattle diseases was first started in 1864, and the result was that the Commissioner, Colonel E. T. Dalton, found that the disease *basanto* was well known in all the districts of the Division, and "that every year large numbers of cattle are swept off by it." The most definite statement, however, is that given by Lieutenant R. C. Money, Deputy Commissioner of Manbhum. He states that *basanto* is said always to have been in the district, and the deaths from it always to have been many; but for the last two or three years it is said to have raged more severely than formerly.
1858. In 1858, the Commissariat cattle in the station of Hazaríbagh are said to have suffered from *matah*, and been treated without success with tartarized antimony.

1861. In the year 1861, 22,661 cows and 7,701 buffaloes are reported by Lieutenant Money to have died of *basanto* in Manbhum. The mortality in the same district in 1862 is returned as 26,032 cows and 6,293 buffaloes.
1862. **1863.** The deaths in the year 1863 amounted to 18 098 cows and 54,459 buffaloes.
1864. In the year 1864 many cattle are said to have died in this district; and in the Palamau Sub-division of the Lohardaga District, where the disease called *sitlah* (rinderpest) is said always to prevail, "it increased to an alarming extent." Other diseases, *panja sota* (apparently a more virulent form of *sitlah*) and *khura* (foot and mouth disease) co-existed. Disease prevailed in Manbhum, but to a less extent; but in Palamau the severe epizootic which had begun in 1864 "continued with very little abatement till the end of 1865."
1865. **1866.** Manbhum was visited severely in 1866, and the mortality is put down at 22,000. The disease seems to have spread over the greater portion of the district. *Matah* and *khura* are said to have been prevalent in the District of Hazaríbagh during this year, but the particular localities visited are not specified; and in Singbhum rinderpest is stated to

have been very prevalent in the district. A graphic description of the disease is given by the Deputy Commissioner, Dr. W. H. Hayes. **CHOTA NAGPUR DIVISION.**

No record exists of cattle disease in the Division in the years 1867 and 1868, but this, most probably, is owing rather to an absence of inquiry than to an absence of disease. **Historical Sketch. 1865. 1866.**

Towards the end of the year 1869 *basanto* broke out in Purulia, and in the Parganas Ambicanagar and Simlapal in the Manbhum District, and very widely in the Hazaríbagh District. Cases appear also to have been observed here and there in Singbhum. A very severe outbreak of *matah* is reported to have existed in the Palamau Sub-division of the Lohardaga District. The disease commenced in February and lasted till June, and caused a mortality estimated at from 10,000 to 15,000 head of cattle. Another disease, not named, characterised by watery purging, vomiting, and death in a few hours, exactly resembling cholera, is also reported to have been prevalent. Small-pox prevailed among men simultaneously with *matah* among cattle. The officer reporting upon this outbreak states that cattle disease (*matah*) prevailed in the sub-division during each of the five years preceding 1869. **1869.**

The Manbhum and Hazaríbagh outbreaks continued to attract attention during the early months of the year 1870, but the disease did not spread widely. A few cases were from time to time brought to notice in the Singbhum District, but the Commissioner, writing in September, reported that the Division was free of disease. **1870.**

In 1836, Dr. K. Mackinnon, then Civil Surgeon of Tirhut, in reply to the circular of the Medical Board, describes the frequent prevalence of the disease *matah* or *gutí*, and gives the symptoms of that murrain. **PATNA DIVISION. 1836.**

Mr. John Stalkartt observed the same disease at Bongong, in Tirhut, in 1845, and lost about three-fourths of about 200 pairs of bullocks. **1845.**

No date can be assigned to the first appearance of cattle murrain in this Division. The oral testimony of the inhabitants of some villages in the Bhabua Sub-division, whose evidence was recorded by the Commission on the occasion of their visit to that locality in June 1870, was to the effect that the affection called *matah* was known from time immemorial, and broke out every two, three, or four years. Mr. C. C. Stevens, Assistant Collector of Baxá, who in 1866 inquired very fully into the cattle diseases prevailing in the same district (Shahabad), writes that both *gutí* and *khura* (rinderpest and foot and mouth disease) have been known there from about 30 or 40 years, and mentions that the natives of the district assert that these diseases, as well as cholera, come from Bengal. Mr. Hope, the Collector of Behar, writing in 1864 states that small-pox attacks cattle in that district every year, or every other year, most violently "at the conclusion of the hot weather and beginning of the rains." Mr. J. J. Grey, Collector of Sarun, discovers in the same year that *matah* is frequently prevalent amongst the cattle of the district. Here, in fact, as in every other part of Bengal, 1864 marks the period when attention was first directed to losses among horned stock from disease, and the blank in the local records of murrain, which only begin about this period to show a few vague but significant traces, simply indicates an absence of observation. These traces shall here be put down in chronological order.

The existence of cattle murrain in Behar from about 1858 is inferred from Mr. Hope's statement in 1864, that "for the last six or seven years the small-pox has been prevalent to an alarming extent among the cattle of the district." The losses from the disease are said to be an occasion of distress and ruin to agriculturists, and the description of the symptoms leaves no doubt of its being rinderpest. **1858.**

OXEN. | **Selections from Report of Indian Cattle**

PATNA DIVISION.

Historical Sketch.

1859. Mr. A. J Elliott, Collector of Tirhoot, mentions that 40 or 50 bullocks died of *guti* in a factory in his district in 1859.

1861. In 1861 *matah* is said to have been very bad in the south-east of the District of Saran.

1862. In 1862 there are several notices of the prevalence of cattle disease. On the Tirhoot banks of the Ganges, small-pox is said by Mr. A. M. Cole, Deputy Magistrate of Barh, to have carried off "vast numbers" of cattle. The disease *guti* is said to have been prevalent in Chumparun, where the Civil Surgeon, Dr. Coates, made a careful inquiry into its nature, symptoms, and treatment. Segregation and "nourishing slops" are strongly recommended by this officer, who states that in this way nine-tenths of the herd will be saved. Mr. J. Burke, of the Pusa Stud, describes the symptoms of a disease which attacked the depôt bullocks in this year, which from the *post-mortem* appearances he concluded to be *pleuro pneumonia.*

1863. In December 1863, several cases of *guti* occurred among the Government cattle at Dinapur. Captain S. Chalmers, Deputy Assistant Commissary General, who furnishes this information, states that this disease had recently been very destructive in the adjoining district, and strongly advocates the employment of *kari nimack* for its treatment. In the eastern part of the same district *matah* was severe in March and June, and one cattle-owner, Mr. Curtis, of Ramcolah, lost nearly a third of his stock; another, Khaggee Ramsan Ally, lost upwards of a hundred head of cattle. The symptoms related by Mr. J. J. Grey, the Collector, are most characteristic of rinderpest. In another letter written in February 1864, Mr. Grey states that the disease "last year seems chiefly to have attacked buffaloes." Mr. A. J. Elliot, Collector of Tirhoot, reports in April 1864 that "last year *guti* appears to have been extremely prevalent in the north of the district." Foot and mouth disease attacked, in the rains of 1863, the cattle of the Pusa Stud

1864. In 1864 records of the prevalence of disease are more numerous and definite: *guti* prevailed in the south of the district of Shahabad in the month of June. In the Behar Sub-division of the Patna District "*matah* raged with great severity." In the Dinapur Sub-division of the same District, *dakuha* (apparently a form of rinderpest) prevailed in July and August. Disease prevailed also in the Sub-division of Sewan, of the Sarun District, in the Buxar Sub-division of Shahabad, and in the vicinity of the Pusa Stud, in the Tirhut District. Major C. L. Brown, Pension Paymaster, Dinapur, states that disease existed in that station in March 1864, and was carrying off large numbers. He asserts that the murrain is *gastritis*, and advocates warmly a system of homœopathic treatment.

1865. After the effort of 1864 interest and attention seem to have flagged, and records of disease become more rare. Occasional villages of the Buxar Sub-division of the Shahabad District are said to have been visited by *guti*. *Dakuha* also prevailed in Dinapur.

1866. *Guti* continued to prevail in a scattered way in Buxar in 1866 and *dakuha* in Dinapur. In the Sewan Sub-division of Sarun, *matah* and *waghah* (a species of rinderpest without cutaneous eruption) were prevalent. From a return received on the 1st of October 1870 from this district, 4,600 cattle are said by the police to have been attacked with *matah*, and 1,822 to have died.

1867. From July to December 1867 both *guti and khura* (rinderpest and foot and mouth disease) prevailed in the Rhotas and Chainpur Parganas of the Shahabad District, said to have been imported from the Chainpur hills. In Sarun 4,510 cattle are said to have been attacked with *matah* and 1,030 to have died.

O. 551-594.

Plague Commission, 1871. (*H. T. Pease.*) **OXEN.**

PATNA DIVISION.

Historical Sketch.

1868. From September to December 1868 *sitlah* is reported to have prevailed in the Rhotas and Sasseram Parganas of Shahabad. In Sarun 4,129 cattle are stated by the police to have been attacked with *matah*, and 1,889 to have died.

1869. In January 1869 *sitlah* was reported to be dying out in the Bhabua Sub-division of Shahabad, in May it was again heard of in the Rhotas and Sasseram Parganas, where 42 villages were found by the police to have been affected by the disease. The same disease broke out in April and May in the villages adjoining the Berhampur cattle fair. In Tirhut also cattle disease prevailed in the month of January; at Madhubani rinderpest broke out in March at the station of Dinapur among some cattle which had been bought in February at the Berhampur fair. In November and December "small-pox" prevailed in the District of Gaya at several villages under the police jurisdiction of Uttri. In Sarun, the police report 5,041 cattle attacked, and 2,461 deaths among these.

1870. In the District of Shahabad cattle disease appeared again early in the year in the Chainpur Pargana and Bhabua Sub-division; the disease continued to prevail very extensively until the month of June. On the 8th and 9th of this month the affected localities were visited by the Commission, and the prevailing disease was found to be rinderpest. This disease prevailed in the Sasseram Pargana also in the months of March and April. It was heard of again in August and September in the Chainpur Pargana. In the month of May the same disease was reported to prevail in several villages of the Patna District, but in a very scattered way, and in June seems to have disappeared. In the Gaya District the disease prevailed in January and February in the Purhul and Mohair Parganas. In Tirhut foot and mouth disease was reported in February from the Khajaulí village of the Madhubani Sub-division, and reports came from Pusa in August that a "catarrh with diarrhœa" prevailed in some neighbouring villages. In Sarun the number of cattle attacked by *matah* is put down by the police at 3,468, and of deaths at 1,669; but no particulars are given as to locality, symptoms, treatment, etc.

The information obtained from this Division is very meagre.

BHAGALPUR DIVISION.

The Commissioner, A. Money, Esq., C.B., writing in 1866, states that the inquiries which he had made "lead to the conclusion that a disease called by the natives *guti* or small-pox is never absent from this part of the country; that it attacks cattle during the winter months; and that it closely resembles the epizootic described by Dr. Palmer." Other reporters confirm the truth of this remark, and the periodical appearance of murrain in various parts of the Division at intervals of one or more years is a well understood and acknowledged fact, while data are wanting to determine when this periodical prevalence first commenced. The evidence obtained by the Commission in several villages around Purneah, proves that the appearance of disease stretches beyond the recollection of living men.

The inquiries made by order of the Government of Bengal in 1864 elicited the fact that *chechack* or small-pox was a well-known disease among cattle in all the districts of the Division.

1864. A practice prevailing in the district of Purneah was then brought to light which tends to provide for the frequent appearance and wide spread of contagious disease. Cattle are yearly driven for grazing in January and February from every part of the district to the Morang or Nepal Tarai, where they remain till the middle of June. Both rinderpest and foot and mouth disease are perennially present among the herds on these grazing grounds, and these diseases are carried back by the cattle returning to their several villages. This practice prevails very extensively in India—

BHAGALPUR DIVISION.

Historical Sketch.

indeed whenever the grassy slopes which encircle the base of hills are without easy distance. Writing again in November 1866, the Commissioner reports that in 1864 an unusually large number of cattle died in various parts of the district. He also remarks that the foot and mouth disease is a common one.

An interval of several years now elapses in which no written or printed report exists of any murrain among cattle. That disease was absent from the Division is improbable in the highest degree, and the District Superintendent of Police of Purneah, in a letter dated 14th May 1870, states that the disease was on the decrease during the previous 5 years. This shows that it was prevalent in that district, and though reports are wanting from the others, it may fairly be concluded, from the analogy of other parts, that it might have been found in the other districts as well.

1868. From January to June 1868 both rinderpest (*matah*) and foot and mouth disease (*choam ussia*) are said to have attacked the cattle of Purneah, more particularly in the police jurisdictions of Kishenganj and Babanganj. These diseases prevailed among the cattle which went
1869. to the Morang. In 1869 the disease seems to have been brought back with the herds, and prevailed in the Arrourah Sub-division from October to December In Monghyr also the existence of *chechack* is reported in December in the Balea Pargana, while in the Santhal Parganas rinderpest prevailed in the Nalla and Kurron police stations in March and April. The decline of the disease is attributed to the active efforts made by the police in the way of enforcing segregation and cleanliness.
1870. In 1870 the disease continued to prevail in the Balea Pargana of Monghyr in January and February, and was reported from the Chukye police station in March. Foot and mouth disease appears to have prevailed simultaneously. A few cases of *mahamai* are said to have occurred in the Kishenganj Sub-division in February, and rinderpest was found by the Commission to prevail in the neighbourhood of Purneah in June. The cattle had just returned from the Morang and brought the disease back with them. Another report was received in October, when the existence of disease was discovered in several villages of the Cushamour Thana.

In February 30 cattle were attacked at Lachmanpur Ekdera, in the Bhagalpur District, with a peculiar disease, not named, whose symptoms were,—shivering, falling down, stoppage of evacuations, flow of fluid from the mouth, and death in 3 or 4 hours (poisoning?); 20 of these cattle died. Further reports were at once solicited, but no seizures or deaths, in addition to these, appear to have taken place.

A later report from Bhagalpur mentions that great mortality had been caused in the Lachmanpur police station and Chye Pargana of that district in September and October from swelling of the throat and diarrhœa, attributed by the natives to noxious grasses.

RAJSHAHYE DIVISION.

Abundant evidence exists that cattle murrain visits the districts of this Division frequently and severely, though a very continuous or detailed account of its prevalence cannot be given; neither can any date be
1832. assigned to its first appearance. As early as 1832, Dr. Macpherson, then Superintendent of Vaccination at Murshidabad, observed that cattle were liable to what is called *matah*. There was at this period a very universal endeavour made to discover natural cow-pox. The supply of vaccine lymph obtained from England was unsatisfactory in its results, and it became known that cattle were liable to an eruptive affection to which the natives applied the same name as they applied to human small-pox. What could this possibly be but cow-pox? Dr. Macpherson accord-

RAJSHAHYE DIVISION.

Historical Sketch.

ingly selected some cows suffering under this malady, clothed them in blankets, and removing the crusts which he found developed on the udder on the 9th and 10th days of the disease, used these to vaccinate children, and succeeded in producing a vesicle, to all appearance vaccine. From the vesicle so produced lymph was taken, sent all over India and used for vaccination. This discovery took the medical men of India by surprise, and produced no little agitation at the time. Efforts were made elsewhere to imitate Dr. Macpherson's practice, and the experiments conducted in Sylhet, described under the Dacca Division, and the observations of Dr. Duncan Stewart in Calcutta, presented in the papers relating to the Presidency Division, were the offspring of the Murshidabad experience. Dr. Stewart, however, while sharing in the admiration and appreciation accorded to Dr. Macpherson's "valuable discovery," makes some very suggestive remarks upon the subject. This sagacious physician wonders why the lymph of the vaccine vesicle of the cow was not used instead of the crust, and remarks that the stages of progress of the pock were not minutely described. We now know that if the cases selected by Dr. Macpherson were what is now called *matah* in the cow—and this is exceedingly probable, for the murrain seems to have been extensively prevalent in the district—he might look in vain for a well-defined vesicle or pustule, and that the eruption is essentially crusty or scabby *ab initio*. The most remarkable peculiarity noted in describing the effects of the inoculation of human beings with these crusts is,—that the effects were more severe than those caused by the usual vaccine virus, and this was looked upon as rather an advantage, inasmuch as it recommended the procedure to the natives of the country who had hitherto been accustomed to the more violent manifestations of variolous inoculation. In Calcutta the lymph soon became mixed up with that hitherto in use, and there is an absence of accurate detail as to its behaviour and results in other places. It was, no doubt, soon superseded by the regular supply, and it does not appear that, with the exception of the unfortunate Sylhet experiments, any effort was made at Murshidabad or elsewhere to repeat Dr. Macpherson's practice.

The following précis of Dr. Macpherson's proceedings is extracted from the "*Transactions of the Medical and Physical Society of Calcutta,*" in which these and other interesting papers received by the Medical Board on this subject are printed:—

An account of some experiments relative to vaccination, by G. G. MACPHERSON, Esq., *Superintendent of Vaccination, Murshidabad,—dated 29th November 1832.*

Board's Circular. Efficacy of vaccination.

Dr. Macpherson quotes a circular from Medical Board,—dated 4th June 1831, to the effect that public confidence has been so shaken in the powers of vaccination, owing to its failing in many instances to protect against severe and even fatal attacks of variola, that it is desirable to institute a series of investigations and experiments for the purpose of regenerating the virus, and restoring it to its pristine activity, if so be that it has degenerated.

Dr. Macpherson remarks that in his own experience he has invariably found vaccination prophylactic against variola, and cites instances of vaccination, induced with difficulty and imperfectly, modifying a subsequent attack of small-pox. He also suggests that much spurious vaccination is practised.

Variolation of cattle unsuccessful. Animal vaccination failed.

He states that small-pox prevailed severely in Murshidabad and its vicinity in May, June, July, and August 1832; he tried to induce variola in cows by inoculation and covering with contaminated blankets, but this was only followed by fever, and a few ulcers on the abdomen in one case. Two cattle inoculated from these ulcers showed no symptoms of disease. He next vaccinated two cows, which fevered, and one had on the 5th day a vesicle from which two children were inoculated, but only spurious vaccination was induced. He proceeds,—" on inquiry amongst the natives, I learnt that the cows in Bengal are subject to a disease which usually makes its appearance about the latter end of August or early in September, to which the same names are given as to variola in the human subject, namely *basanto*, *matah* or

Basanto.

RAJSHAHYE DIVISION.

Historical Sketch.

Symptoms.

guti; and on the 24th of August I was informed that several cows belonging to a native of Moydapur were affected. I consequently determined on again attempting to regenerate the vaccine virus from the original source. The animals which were at first affected, amounting in one shed to 18 or 20, had been for a day or two previously dull and stupid. They were afterwards seized with distressing cough, and much phlegm collected in the mouth and fauces. The animals had apparently at this time no inclination for food, or at all events they were unable to satisfy their hunger. Their suffering seemed to be greatest on the 5th and 6th days when there was considerable fever, and pustules made their appearance all over the body, especially on the abdomen, which terminated in ulceration, the hair falling off wherever a pustule had run its course. The mouth and fauces appeared to be the principal seat of the disease, being in some instances one mass of ulceration, which in all probability extended to the stomach and alimentary canal. In those cases where the mouth was very much affected, the animals died apparently from inanition; whereas in those cases in which the power of mastication or even of swallowing was retained, recovery was much more rapid than might have been expected, from the previous severe sufferings and reduced state of the animal. The mortality may be calculated at from 15 to 20 per cent."

Comparison with cow-pox.

Inoculation of children. Effects.

He next remarks on the severity of this disease as compared with cow pox, as described at home, on the suppression of the secretion of milk in India, and on the non liability of human beings to infection—a belief firmly held by natives. He now selected two cows belonging to one of his vaccinators suffering from *matah*, covered it with blankets, leaving the teats and udder exposed, and "on the 7th day two small pustules appeared on the teats of one, which dried up on the 10th and the crusts were removed on the 12th day." From these 11 native children were inoculated. In six no effect whatever appeared, two had very slight inflammation on the 3rd and 4th days; two had considerable local inflammation and slight heat of surface on the 5th, 6th, and 7th days, but no vesicle formed, although there was marked induration round the puncture. "The remaining child's arm was slightly inflamed on the 4th morning, and a vesicle was apparent the next day, which continued to increase till the 9th day, when I was much gratified to find that it assumed all the characteristics of the vaccine." The child, 5 months old, suffered much from fever for 4 days. In subsequent vaccinations the symptomic fever was particularly severe. The disease was now disseminated. Two of the children thus vaccinated were inoculated with small-pox, and both were found protected; 5 children thus vaccinated were exposed to small-pox infection without result. Several European children were successfully vaccinated. During the prevalence of *matah* among the cattle no case of small pox among human beings occurred.

Protectiveness.

1833

The disease *matah* again broke out severely in Murshidabad in April 1833. The experiments above described were again tried, but Dr. Macpherson failed to obtain pustules. The mortality among cattle was great. A child was inoculated from a pustule on the udder of a cow. Slight inflammation of the arm ensued on the 4th and 5th days—no other result. There was no coincident small-pox among men, and no other animals were affected.

1834.

In 1834 small-pox prevailed among men in Murshidabad. Variolation was again attempted on cows and calves, but unsuccessfully.

1835.

Dr. Macpherson writes on the 4th of January 1835 that no case of *matah* had come to his notice since 1833. The unfortunate Sylhet experiments had by this time been published and discussed, and evidence collected elsewhere by the Medical Board placed the severity of the newly discovered disease of cattle in such a strong light that the mind of the profession refused to accept it as an approved substitute and representative of vaccinia, and the whole matter appears to have dropped.

1856

1860-64.

1864.

There now ensues a blank of 21 years in the history of cattle disease in this Division, but there is a distinct statement in a letter written by Mr. R. T. Scott, the Commissioner of Rajshahye, in February 1864, that "small-pox" was epidemic among the cattle of the Rajshahye District 8 years before then. Mr. Cockburn, the Manager of extensive estates in the same district, states that *basanto* "prevails throughout Bengal," and has been on the increase during the past three or four years. In

RAJSHAHYE DIVISION.

Historical Sketch.

1864 more careful inquiries were made regarding cattle diseases, and in this Division the results were the same as throughout the whole of Lower Bengal, namely, that cattle murrains were found to be frequent and fatal "Murrain" in Maldah is said to have "visited the district periodically, commencing in the month of August and extending up to the end of April, fluctuating in its severity and carrying off a great many cattle." In Murshidabad a great number of cattle are said to die annually from epizootic disease. Several villages in this district were visited by the Cattle Plague Commission in June 1870, and the universal testimony was that frequent outbreaks of the disease *matah* or *basanto* prevailed. One man of 90 years, the *mundul* of a village, stated that he had seen the disease four times in his life, and that it prevailed there when he was a boy 10 years old. This removes the disease back to 1790. Other statements were much to the same effect, some saying that they had seen the disease 10 years ago, some 20 years ago, and so on. The same is said of the Rungpur District. In Dinajpur *gutl* is asserted to prevail frequently, and "often sweeps off herds of cattle." In Rajshahye *basanto* occurs at intervals of 2 to 4 years. In fact, the same tale is everywhere told in nearly the same words, and its burden is summed up in the expressions "periodical prevalence" and "great mortality;" and it is curious to observe here what is equally evident in other places, namely, that men, such as agents of estates, zamindars, etc., who obtain a more intimate acquaintance with the rural life of India, lay a greater emphasis upon this matter. The experience of the Commission has abundantly affirmed the truth of this observation, and shown that, unless in seasons of great and exceptionally severe mortality, the people endure their losses uncomplainingly, and that in order to get at the real state of the case, the smooth stolidity or unconcern which would ignore, conceal or deny the existence of disease among their cattle must be disregarded, and a searching, house to house, and village to village, investigation made 1865.

The only record of disease in 1865 is from Rungpur, where the Commissioner, Mr. W. Le F. Robinson, writing in January 1867, states, on the authority of the Magistrate, that disease, evidently rinderpest from the symptoms assigned to it, raged at intervals during the two previous years. A belief prevailed that disease was brought into the district during the Bhutan war by the strange cattle passing through it, but the truth of this is doubted by the Commissioner, who remarks that the disease was known in the district before, and that not many cattle passed through the district, though a great many were taken out of it. In 1866 a similar disease prevailed in Bogra very severely, and not more than 5 per cent. of the cases recovered. It is curious to note, now that the symptoms of the prevailing murrains come to be more closely investigated and better understood, that there is a tendency to doubt the propriety of calling them small-pox. This feature is very well illustrated in Mr. Robinson's letter. He compares the cattle disease prevailing in Bogra to cholera, and while a very correct and detailed description of the symptoms renders it manifest that the murrain was nought else than rinderpest, and precisely *what the Commission has found the natives call by their names for small-pox*, it is said, in Rungpur, that "all agree that it is different from other diseases prevalent among cattle, *such as small-pox.*" The great difficulty has always been the absence of pustules, which is pointedly noted in the case of the Bogra disease. As this matter, however, has been amply discussed, in treating specially of the nature and symptoms of cattle disease, it need not be further enlarged upon here.

1866.

1867.

OXEN.	Selections from Report of Indian Cattle

RAJSHAHYE DIVISION.

Historical Sketch. 1868.

Two elaborate statements received from the districts of Rungpur and Dinajpur, showing the prevalence of cattle disease in each Police Division of these districts, evidence the wide prevalence of *basanto* and other diseases during this year, 1868. It appears also from a letter written by H. C. Wake, Esq., C.B., Deputy Commissioner of Darjeeling, in June 1864, that the cattle of these districts are driven to graze in the Tarai during the dry months of the year. This practice provides, as in the case of the Purneah District (see Bhagalpur Division), for keeping up infectious disease. Cattle are driven to one tract of country from hundreds of different places, from one or more of which infectious disease may be conveyed. This spreads among the herds which are in free association with each other, and when the time comes for the cattle to return to their several villages, the disease returns along with them, and is thus carried to places where it had not previously existed. Under these circumstances it is probable that very few, if any, young cattle escape being attacked with the disease; *and they thus acquire a protection which accounts for only a certain proportion of stock being in any one season seized with the disease.* In 1869 disease continued to prevail extensively in Rungpur and Dinajpur; it also broke out in Bogra and Rajshahye in November, and in Murshidabad in December. This

1869. latter outbreak has continued to prevail and spread throughout this

1870. district up to the end of December 1870.

The localities principally affected have been in the Sadar and Jungipur Sub-divisions.

In Rajshahye also reports of a severe outbreak of *basanto* were received in June from the Nattore Sub-division.

In the district of Bogra the disease of 1869 continued to prevail during the months of January and February, and in the Dinajpur District reports received in April showed that the disease was still prevailing extensively, 678 head of cattle being noted as still ill when the investigation was made.

NEPAL.

Prevailing Diseases of Cattle.

NEPAL.

Letter from Dr. D. Wright.

The following note on this subject has been communicated by Dr. D. Wright, Residency Surgeon at Katmandu It confirms the evidence recorded at Darjeeling with regard to Thibet, showing that murrains are common occurrences on these hills, and, moreover, adds another link to the chain of evidence which proves that the Tarai is a "home" of cattle plagues.

"The diseases of the cattle here are six in number:—

1.—*Sore mouth.*—The animal is unable to graze, and saliva and froth flow from the mouth. The disease is infectious. In the first three days nothing is done in the way of treatment; after that *chuk*, *i.e.*, lime-juice, thickened by boiling, is applied to the sores and given also internally. The disease is seldom fatal.

2.—*Foot Disease, khoraha.*—The animal is lame from sores between the hoof, and cannot walk. The disease is infectious and spreads rapidly among cattle. The treatment adopted is to make the animal stand daily in water for some time, and then to apply the juice of garlic. If maggots make their appearance, the pounded leaves of the peach tree are applied.

3.—*Diarrhœa and dysentery.*—This disease is very infectious, and is always fatal. The symptoms are,—sunken eyes, dry mouth, and bloody motions; no treatment is known to do any good. If

NEPAL. Historical Sketch.

there is merely watery diarrhœa, then *ganja*, salt, and *gur* are given daily in equal parts along with some rice. The dose of the mixture given is one tola weight.

4.—*Khun ka bimari, blood disease.*—The symptoms are,—flatulency and constipation, retention of urine, staring coat, and drooping ears. The only treatment adopted is to give the animal the *ujmoda* or *jwain* plant to eat, which produces a discharge of urine and dung.

5.—*Fever.*—This is considered a fatal disease, and there is no treatment for it. Buffaloes when attacked by fever are frequently bathed in a tank or river, and generally recover.

6.—*Catarrh.*—The treatment for this is the same as for murrain.

"The infectious diseases are generally brought into the valley by the herds of buffaloes and cattle that come from the Tarai and Bhutan.

"Such is all the information I can get out of my learned native, and the result of it all seems to be that both foot and mouth disease and the rinderpest are common enough in Nepal, and are known to be contagious and to be imported from the neighbouring districts.

"The foot and mouth disease was prevalent during the past year, but just now the valley is free from disease."

COOCH BEHAR DIVISION.

In this, as in other Divisions, no precise date can be assigned to the first appearance of murrain among cattle, and the officials and inhabitants concur in asserting that plagues of various kinds have been of frequent occurrence, and that these occurrences extend beyond the recollection of the present generation.

On this subject, Baboo Goonabhi Ram Burooah, Extra Assistant Commissioner of Gowalparah, writes,—"The oldest of men living cannot give any satisfactory account on this subject (history). The increase of communication between one place and another has brought and spread the plague." "Plagues occurred in Goalpara in 1851, 1852, 1868, and 1869. Between these years also the plagues raged in the district, but in them it was very severe." Mr. Wake, C.B., Deputy Commissioner of Darjeeling, mentions that in 1860 there was a great deal of loss of cattle from disease in the hills, and that it appears to have been imported from below (the Tarai). Surgeon J. C. Collins, writing in 1861, states that during the time that preparations were being made for the Sikhim Campaign in 1861, a very fatal disease broke out among the Commissariat cattle employed in bringing up stores from the plains. This outbreak was described by several witnesses (Sikhim men) examined by the Cattle Plague Commission, who also deposed that the disease affected the cattle of several Sikhim villages at the time. They further informed the Commission that rinderpest, known there as *yor*, was well known in Sikhim, and appeared periodically from time beyond recollection in their country. A man from Thibet—Jungpen, a cattle doctor—was examined on the same occasion, and testified to the prevalence of the same disease known as *chunneah* in Thibet, and his account of the spread of the disease east and west from Sarka, the salt-producing district, will be found at page 260. Foot and mouth disease (*khuchha*) was known in both countries, also in Bhutan. Both these diseases affected wild as well as tame ruminants.

1851-52.

1860.

1861.

Rinderpest is stated by Mr. Wake to have been prevalent in the Tarai in 1863. He also mentions that numbers of cattle of all kinds died of the 1863.

OXEN.	Selections from Report of Indian Cattle

COOCH BEHAR DIVISION.

Historical Sketch.

1864. same disease. Most of these came during the cold weather to graze, returning to Rangpur, Purneah, and Dinajpur at the commencement of the rains. The next record of cattle plague is contained in the evidence of Mr. John White of Sonada, who states that in 1864 at Maldram, about 4 miles on the Sonada side of Kurseong, a Lepcha named Ramproot owned 150 head of cattle, and lost them all from a kind of dysentery. They passed blood, and the interior of the rectum was seen to be of a dark, bloody, liver colour: "these cattle had no sore feet." Mr. Herrold, Manager of the Bullock Transit Train, finding that plain **1865.** cattle did not stand hill work, sent men early in November 1865 to collect cattle of the hill breed from the Morung. A few days after their arrival, towards the end of December, two became ill, one at Darjeeling and the other at Kurseong, on the same day: these died within 36 hours. The remainder, which had been with the diseased cattle for a whole night in the same shed, were removed, but they "dropped off day after day (of the same disease), until on the 15th of December I had not one left of the herd of upwards of 40 head." The symptoms described by Mr. Herrold are such as to leave no doubt that the disease was rinderpest.

Lieutenant-Colonel Agnew, writing in August 1866, states that cattle disease somewhat similar to the Calcutta epizootic is not uncommon in the Duars and Cooch Behar, and that in the Eastern Duars it proved very fatal last year (1865). The Deputy Commissioner of the Duars reported that the carcasses of diseased cattle were to be seen in every villages and no precautions were taken to remove dead bodies.

1866. Mr. Herrold's cattle again suffered in 1866. He says,—"In March I purchased 70 head of cattle from Nepal, and a week afterwards the foot and mouth disease, called by the natives *khurats*, broke out among them. In April the first disease mentioned (rinderpest) broke out again among some new cattle the Commissariat had purchased from Bhuteas, and in a very short time nearly all died. Some of these cattle, in a diseased state, were continually moving about the cart-road spreading infection, by which I lost very nearly 150 head of draught cattle, several head of milch cows and calves, and a great many natives in the vicinity of the cart-road lost their buffaloes and cows. I believe this disease is very common in Nepal; natives call the disease *dosalin*—plague." The Darjeeling Municipality now took over charge of the train lately under Mr. Herrold's management, and at the depôt at Sonada a great many cattle died—in fact, so many, that the train was closed for a time. Mr. J. White, who had charge of this depôt, states that all the cattle purged and passed blood. Mr. White further states that the disease had occurred yearly in the hills since that period. Rinderpest also prevailed in Hopetown (Mr John Stalkartt's tea garden) in 1866.

1868-69. Baboo Goonabhi Ram Burooah states that rinderpest was very severe in Goalpara in 1868 and 1869.

1870. Early in September 1870, foot and mouth disease broke out at Sukni on the new cart-road between Silligori and Kurseong. It had previously been heard of at Titalyah and Silligori on the Darjeeling road, and it spread stage by stage up the hill until it reached Darjeeling. Kurseong and Darjeeling were visited by the Cattle Plague Commission in October. The disease was found to be foot and mouth disease; the mortality was found to be very great on account of the contractors having to work their cattle after they became affected, in order to fulfil their contracts. It was ascertained that the mortality of cattle belonging to contractors was between 40 and 50 per cent., while the deaths among the cattle of owners who had no contract was only about 12 per cent.

COOCH BEHAR DIVISION.

Historical Sketch.

The statistics furnished by the Police are as follows :—

Locality.	Attacked.	Died.
Darjeeling	137	28
Kurseong	333	140
Mateigarh	323	...
Sonada	45	17
Phansigarh	43	2
TOTAL	881	187

The mortality is about 21 per cent., rather less than a mean between the rates ascertained by the Commission to prevail amongst the cattle of contractors and private owners.

CHITTAGONG DIVISION.

1864.

W. Gordon Young, Esq., Commissioner of Chittagong, writing in January 1864, states that in the district of Noakhali cattle murrain frequently appears in September and October, and that in Tippera "it has been for many years past very destructive among the cattle."

In Chittagong, "where cattle are not numerous, no such murrain has apparently ever prevailed." The disease is called *basanto* and *Burrapera*.

1865.

In Tipperah disease (*matah, sitala or basanto*) prevailed throughout the district, and in July and August attacked the cattle of the sudder station Commillah. The detail of symptoms leaves no doubt that it was rinderpest.

1866.

Rinderpest continued to prevail very extensively in the district up to the month of September 1866. The mortality appears to have been very great, and type of the disease virulent.

1868.

No record of the year 1867 has been furnished, but in 1868 rinderpest is said to have been very prevalent throughout the district of Tippera, and caused a mortality of 3,000 or 4,000.

1869.

The disease continued to spring up in different localities throughout Tippera, and the mortality is thought to have been even greater than in 1868. The district of Noakhali was also this year severely visited, and *basanto* (rinderpest) was reported to prevail very generally. In Chittagong, also, a partial outbreak of the same disease took place in the sub-district of Cox's Bazar.

1870.

Lord H. Ulick Browne, Commissioner of Chittagong, in a letter, dated 8th February 1870, states that cattle disease does not prevail in the Chittagong District; that in Tipperah there is little disease; in Noakhali it has prevailed largely during the last three or four months, and in the hill tracts of Chittagong it was rather bad three or four months ago. "The truth I believe to be that the disease comes and goes, is virulent and mild at intervals in most districts."

In November a report was received from Tippera that *guti* (small-pox) prevailed in many villages of the Station Ballia. A subsequent report, dated 5th December, intimated the disappearance of the disease after 169 cattle had died, and a still later letter, dated 28th December, informed that the disease had re-appeared in one village, where seven cattle had died.

Mr. Raban, Magistrate of Chittagong, reported, on the 17th October, that "small-pox" was prevailing in the Chittagong District, having broken out in September: 107 cattle had died among 130 attacked in a stock of 750 head.

OXEN.	Selections from Report of Indian Cattle

ASSAM DIVISION.

Historical Sketch.

Subsequently, no disease was reported to prevail in the district, but this was afterwards explained to refer to the town of Chittagong. This division was not visited by the Commission, because the reports received were too indefinite to undertake a long and expensive journey upon; but the papers appended to this summary will conclusively prove that the same diseases affect cattle in the districts of the Division, very much in the same manner as they do elsewhere in Bengal.

It is certain from the oral testimony of several inhabitants of Assam, obtained by the Commission on the occasion of their visit to that province, that cattle disease prevailed there previous to the British occupation. This event dates from 1824, when Assam and its Dependencies were annexed to the British territories during the first Burmese war. They were formally ceded by the Burmese by the treaty dated 24th February 1826. The ceded territory was attached to the Commissionership of the North-East and Rungpur. In 1833 the territory of Upper Assam (the Districts of Lakhimpur and Sibsagar excluding Sadiya and Matack) was placed under the administration of Rajah Poorundur Singh, but in consequence of the failure of that Chief to provide adequately for the protection and well-being of the country and its inhabitants, and in consequence also of his neglect to render the stipulated tribute, the territory was resumed in 1838. After resumption it was administered by the Government of India in the Political Department, through the Commissioner of Assam and Governor General's Agent, North-Eastern Frontier, till 1839, when by a proclamation, dated 31st July, it was annexed to Bengal. The earliest murrain of which information could be obtained was that which occurred in the District of Sibsagar in the year 1722, Sicabda (1797). This fact was communicated to the Commission by Babu Mohun Chunder Burooah, Munsif of Dibrughar, who had heard the circumstance mentioned by his father.

1797.

Veterinary Surgeon Farrell writes in his report, dated the 2nd April 1870, as follows:—"I came across an old Gossain who produced a book written in the Assamese character, and read from it that in the year 1818 the Burmese invaded the country with a large army, and that soon after their arrival in Assam a great plague broke out amongst the army cattle and destroyed them all, spread into the country, and committed similar devastation" The next notice of murrain is by Major Thomas Lamb, Deputy Commissioner of Darrang, who states that the first plague known in that district occurred in 1825, but that no detailed account of it is procurable. A witness, Mohun Gossain, deposed that murrain existed in the district of Rangpur or Sibsagar 10 or 12 years before the English took over the government of that district (1838). Another witness, Gunga Nath Nath, Munsif and Subordinate Judge of Gauhati, while informing the Commission that a plague prevailed in Tezpur in 1848, said that his father, then a man of 50, told him that a similar plague had prevailed when he was a young man of 28 or 30. This again gives the year 1824 or 1826. He also stated that before the British rule there was no regular communication between Assam and Bengal. The only cattle that ever came into the country were a few sent to the Assam Rajah by the Rajahs of Goalpara and Cooch Behar in the shape of buffaloes. Another witness, Hood Gossain, aged 65, a resident of Lahowl, District Lakhimpur and a Government pensioner, told the Commission that cattle plague had occurred in the year 1830 or 1831. The next outbreak of which there is any record or recollection is that which took place in Darrang and Kamrup in 1848, 1849, and 1850. The murrain at Tezpur was witnessed by Colonel R. Campbell,

1818.

1825.

Plague Commission, 1871. (*H. T. Pease.*) | **OXEN.**

who says :—"In 1849 and 1850 plague attacked cattle at Tezpur, and so many cattle died that it was found impossible to remove them." In **ASSAM DIVISION.**
1852 and 1853 a severe murrain prevailed throughout Assam. Mr. Grote, Secretary to the Board of Revenue, estimates the total mortality at **Historical Sketch.**
120,000 cattle. The symptoms and *post-mortem* appearances of this plague were carefully described by Drs. Long and Maclean in the **1852. 1853.**
Journal of the Agricultural and Horticultural Society, Volume XIII, page 270. The disease is said by Dr. Maclean to have commenced in Kamrup in 1852, and gradually to have worked up the valley through Nowgong and Sibsagar to Lakhimpur. The Revd. E. H. Higgs, a resident of Dibrughar, carefully studied the disease in that
station in 1854 and 1855. He states that it was imported from Golaghat **1854.**
by a detachment of sepoys rejoining their corps at Dibrughar. He **1855.**
also states that at that time the natives informed him that the district was visited by murrain every 20 years, and that since 1855 it has prevailed more or less every year throughout the district.

In 1864 the Commissioner of Assam reported upon the subject of cattle murrains in reply to a general circular issued by the Government throughout Bengal. The outbreak of 1853 is mentioned by the Deputy Commissioner of Nowgong, who put down the number of deaths at 21,625 in that district.

The Deputy Commissioner of Sibsagar states that in 1856 there **1856.**
was great mortality among cattle. From Kamrup the following report was received by the Commissioner :—"A cattle murrain, apparently similar to that mentioned in the correspondence," (Madras) "has been known in this district during the past eight years (1856-64) in the months of April and May and September and October." Cattle murrain visited
the District of Darrang in the years 1860, 1861, and 1862; and the **1860. 1861.**
Deputy Commissioner observes that the tracts visited in 1860 were those **1862.**
in which the disease made least havoc in its next visit, and that one attack of the disease confers immunity from a second; and in the Sibsagar report it is stated that "domestic animals alone were not attacked, as deer and other wild animals were found dead in the jungle with the same symptoms." Dr. White also stated in evidence that rinderpest prevailed in the Lakhimpur District in 1861, and that outbreaks have been of yearly occurrence since then. Mr. J. D. Campbell, a Tea Planter
of Mungledai, Darrang, mentioned that during the monsoon of 1864 **1864.**
foot and mouth disease prevailed in the district; and Mr. Driberg states that this disease is very common in that district, but seldom fatal. Colonel Agnew's general conclusion in 1864 was, that disease had prevailed in different districts of the province at various intervals within the last 10 years. Colonel Hopkinson, writing in August 1866, states that in the Khasia Hills, and notably at Cherrapunji and its vicinity, a
cattle disease was prevalent in August 1865, and showed itself to be very **1865.**
fatal. No reports of any epizootic disease among cattle had been received by him from the other districts since 1864.

Captain John Gregory informed the Commission that there was murrain **1866.**
among cattle in Nowgong in October and November 1866. A violent outbreak of cattle murrain took place in the western portion of the Darrang District, more particularly in the Sub-division of Mungledai
in 1867. The disease commenced in April and subsided in September. **1867.**
The loss, according to the return submitted by Major Lamb, the Deputy Commissioner, was 5,971 head of cattle. Mr A. Imthurn, the Civil Medical Officer, gives the symptoms of this outbreak; he mentions particularly that no unsound state of the hoof was perceptible, and no case of recovery heard of. This description and the evidence of Messrs. Driberg, Bruce, and Campbell leave no doubt that the outbreak was one of rinderpest.

OXEN.	Selections from Report of Indian Cattle

ASSAM DIVISION.

Historical Sketch.

1868. In 1868 severe murrain broke out in Kamrup. The disease appeared with great severity in April, May, and June, and affected not only cattle, but also sheep, goats, pigs, and wild animals. Dr. Purves' description of the disease leaves no doubt that it was rinderpest. It also prevailed at the same time in the Khasia Hills, and spread gradually into Central and Upper Assam, namely, into Nowgong, Sibsagar, Darrang, and Lakhimpur. The fortnightly reports of mortality called for by the Commissioner and summarised in Appendix No. 3 show that during the

1869. 1870. years 1869 and 1870 murrain continued to prevail in all the districts of the Division. The disease was introduced into North Lakhimpur in March 1869 by a batch of Bengali buffaloes passing through the villages of Narainpur and Bangfang, near the Dikrang river. One of these buffaloes died of murrain close to the camp of the Deputy Commissioner. The disease spread through the sub-division during the succeeding months before it had appeared in the southern part of the district. The introduction of the disease into Dibrughar and its vicinity was precisely similar to the mode in which it was imported in 1854, namely, by a detachment of sepoys rejoining the head-quarters of the 42nd Assam Light Infantry from Golaghat, where the disease was raging. This happened in June 1869. This Division was visited by the Commission in January and February. An hospital was established near Dibrughar and systematic operations conducted. A large mass of information was obtained from officials, planters, and natives, and is printed in detail in the sequel. The information obtained with regard to this Division is very complete, considering the difficulties in collecting it—physical and moral—which exist; and as here the first impressions of the Commission were gained and the most deadly disease witnessed, the evidence amassed has not been curtailed. Towards the close of the year the disease gradually died out, and from the December reports it appeared that only a few scattered cases were occurring.

PROVINCE OF OUDH. The Province of Oudh furnishes evidence, as clear and ample as that already considered under the other Provinces of the Bengal Presidency, of the frequent and widespread prevalence of murrains among cattle. Early records are, however, wanting, and not until very recently has the subject become matter of general attention or careful enquiry. This attention and inquiry have revealed so much sickness and death among cattle in nearly all the districts of the Province, that it cannot be believed that the revelations of 1870 disclose an exceptional prevalence or severity. This view is further supported by the oral evidence obtained by the Commission in the neighbourhood of Lucknow in May 1870. The villagers were unanimous as to the periodical prevalence of murrain, and several distinct instances of plague—in 1840, 1850, and 1859—were mentioned. Here, as elsewhere, there are a great variety of cattle diseases, known under different vernacular names; and it is difficult from the confused and meagre description to identify them; but rinderpest and foot and mouth disease stand out prominently among them, the former known by the names *pokna, vaba, debí, haiza, bade, rose, marrí, burrí,* etc., and the latter called *khura, chupka, khang,* etc. Having premised these general remarks, the information obtained from each Division will now be systematically summarised.

Sitapur Division.

This Division forms the north-western part of the Province, and comprises the Districts of *Hurdui, Sitapur,* and *Kheri.*

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SITAPUR DIVISION.

Historical Sketch.

1861.

It appears from information supplied by Messrs. Carnegy and Foy, who hold land in the northern part of the District of Kheri, that murrains are frequently prevalent in the breeding tracts of the Nepal Tarai. Mr. Carnegy states that in 1861 a plague among cattle prevailed, and, writing in 1870, he says that cattle disease existed annually during the past eight years in the neighbourhood of his estate. Cattle are here herded in the same way as in the Darjeeling and Kumaun Tarai, and murrain is here also perennially present, being conveyed into the plains when the cattle return, and finding its way occasionally into the hills of Nepal. Mr. Carnegy's interesting statement links together the information obtained regarding the jungle tract or Tarai east and west (*vide* page 253).

1867.

In November 1867 "a fatal cattle disease" was reported to exist in the District of Hardui. "Hundreds of cattle" were dying in the villages of the district of a murrain characterised by bloody purging and in some cases maggot-infested mouth. Efforts were made to segregate, and cattle were ordered *not to be impounded*, in case disease might be spread by this means. The symptoms of this murrain were studied by the Civil Surgeon, Dr. McReddie; they are those usually assigned to rinderpest. He notes that the mortality was about 50 per cent. The statistics of this outbreak are entirely wanting, but the Deputy Commissioner notes that 50 and 100 cattle had died in two villages where particular inquiry had been made, and he was struck with the number of skeletons of cattle lying near them.

This murrain was considered to be infectious, and measures were adopted, apparently with success, to segregate cattle and prevent the spread of the disease to neighbouring districts. Inquiries were made about this time in the adjoining District of Kheri, but no disease was found to exist. The Hardui disease seems to have died out in December; it was called *murrí*,—an indefinite term applied to any disease with much mortality.

Although no official record of disease in the Kheri District in 1867 exists, it appears from Mr. Carnegy's statement that murrain did prevail in the northern part of the district from April to October.

1868.

It appears from returns prepared in 1870 that cattle diseases prevailed in the District of Kheri both in 1868 and 1869. It is evident from the figures given with regard to 23 villages that a considerable mortality took place, and from the symptoms assigned to the different diseases named, though these are by no means clearly distinguished, it is evident that both rinderpest and foot and mouth disease prevailed, swelled throat being also mentioned under the term *gatarua*. Disease appears also to have prevailed in the District of Sitapur during the year 1869, the returns prepared in July 1870 assigning a considerable mortality to that year, and mentioning also outbreaks in the Baree Tahsil in the years 1858, 1859, 1860, 1861, and 1862.

Cattle disease prevailed in the Sandila Tahsil of the District of Hardui in September 1869, having spread thither from the Mulliabad Tahsil of the Lucknow District across the Gumtí river. The disease abated in October.

1870.

In 1870 murrain seems to have prevailed in all the districts of the Division. It broke out in Kheri and Sitapur in April, and periodical returns were received from these districts from July to December, showing that considerable losses of stock occurred. These returns are given in a summary form in the sequel. In Hardui disease broke out in August 1870. Two forms of disease are described by Dr. McReddie,—*barrí*, under which name he describes the symptoms of rinderpest, and *khura*, or foot and

FAIZABAD DIVISION.

Historical Sketch.

mouth disease. Fifty-two cattle had died on the 30th of September of 153 attacked in a stock of 775, or 7 per cent. of stock and 34 per cent. of attacked.

FAIZABAD DIVISION.

This Division forms the north-eastern part of the Province and comprises the Districts of *Faizabad*, *Bahraich*, and *Gonda*.

1867.

In May 1867 cattle disease—called by the natives *galsua*—prevailed throughout the Faizabad District. The symptoms assigned to it are those of rinderpest; the disease was considered infectious, and measures were taken to segregate and isolate the sick. These measures are said to have stamped out the disease. No record of disease exists with regard to the other districts in 1867, nor the Division in 1868 and 1869.

1870.

In February 1870 *poknah* broke out in Sunkheri, in Faizabad, and in August and November in two other localities in the same district; the losses were however small. The figures given are as follows:—

Place.	Stock.	No. attacked.	No. died.	No. recovered.	No. still ill.
Sunkheri	106	29	17	12	...
Gurdaspur	60	16	4	...	12
Nasirpur	135	116	100	4	12
TOTAL .	301	161	121	16	24

This gives a mortality of 40 per cent. of stock and 75 per cent. of attacked. The symptoms assigned are those usually given—bloody purging, etc.

In October of this year, the widespread prevalence of cattle murrain was reported from Bahraich. The diseases prevailing were called *khang* and *gatarua*,—hoof and throat disease. The symptoms assigned to the latter were so anomalous and suspicious that an inquiry was made as to whether cattle poisoning may not have been the cause of the deaths assigned to *gatarua*. This was, however, answered in the negative. The figures given in the reports received are as follows:—

Place.	Stock.	No. attacked.	No. died.	No. recovered.	No. still ill.	REMARKS.
Pyagpur and Puchderorie.	216	181	28	141	12	*Khung.*
Chitramiror . .	254	112	54	29	29	*Khang* and *gatarua.*
Gilawlie	201	31	23	5	3	*Ditto ditto.*
Matabar . . .	...	131	55	45	31	
Siseyaralwan . .	455	194	79	28	87	*Ditto ditto.* *Khang.*
TOTAL .	1,126	649	239	248	162	

RAI BARELI DIVISION.

Historical Sketch.

This gives a death-rate from *khang* of 15 per cent. of stock (taking that of the blank village at 200) and 36 per cent. of attacked; 32 cases are put down to *gatarua*—all fatal.

The Deputy Commissioner states in a letter printed below that 1,073 cattle died among 1,343 attacked (79 per cent.) in 47 villages of the Korasul Tahsil, and 4,176 of 9,838 (42 per cent.) in 219 villages of the Nanpara Tahsil. Though the foregoing information is subject to doubt as regards the type of the disease which prevailed, it is valuable as showing that great mortality took place in the district from murrain.

No information has been received from the District of Gonda.

Rai Bareli Division.

This Division forms the south-eastern part of the Province and comprises the Districts of *Rai Bareli*, *Partabgarh*, and *Sultanpur.*

A return was received from Rai Bareli, dated the 14th April 1870, in which 12 diseases of cattle are named and the statistics of 10 years given. 1869.

1. *Khura*—hoof disease.
2. *Ghurka*—throat swelling.
3. *Haku*— ditto.
4. *Bitharu*—swelling of the jaws.
5. *Kharist*—itch.
6. *Baruck*—swelling of stomach.
7. *Chahan*—bleeding of the nose.
8. *Haisa*—cholera.
9. *Meduki*—sores on the lip.
10. *Baghi*—disease of the bowels.
11. *Tulligana*—worms in the stomach.

The cattle diseases named are marginally put down. Rinderpest appears to be known as *haisa*, and foot and mouth disease as *khura*; for the rest, it is impossible to identify them accurately. The figures given are as follows:—In a stock of 205,904, 25,095 were attacked (12 per cent.), and 18,934 died (9 per cent. of stock and 73 per cent. of attacked). Disease is said to have prevailed from June to September in each year.

No specific record of disease exists until July 1869, when a great mortality was reported from "cholera and *checkuck*" among cattle in the Partabghar District; foot and mouth disease seems also to have prevailed. The mortality for the district is stated at 5,735 head of cattle. The principal disease was no doubt rinderpest. 1869.

In the District of Sultanpur also, *hulka* or cholera broke out in March 1859 in the Musafir Khana Pargana. The statistics of one village only are given by the Deputy Commissioner in a return dated 7th March 1870. In a stock of 243, 56 had been attacked (23 per cent.) and 38 had died (15 per cent. of stock and 68 per cent. of attacked).

During the latter half of the year 1870 murrain prevailed extensively in both the two last-mentioned districts. The particulars forwarded from time to time are given in a summary form below. Cholera—no doubt rinderpest—and foot and mouth disease are the two principal causes of sickness and mortality mentioned. 1870.

Lucknow Division.

This Division forms the south-western portion of the Province and comprises the Districts of *Lucknow*, *Unao*, and *Barabanki* or *Durriabad*.

The first official report of cattle disease in this Division is from Unao in June 1869. The mortality was very great and general; 83 per cent. of the cattle attacked are said to have died. The disease was called *sahurbad*, and smelling of the glands of the throat is the only symptom mentioned. The oral evidence obtained by the Commission showed that cattle disease prevailed in this Division long anterior to 1869. On the 1869.

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LUCKNOW DIVISION.

Historical Sketch.

1st of September the Deputy Commissioner of Lucknow reports that cattle disease had appeared in the Mulliabad Tahsil of that district; the symptoms described point unmistakeably to rinderpest. Isolation and burial of carcasses were enjoined. On the 15th of the same month a further report was submitted, showing that disease still prevailed in Pergunnahs Mulliabad and Mahonah; 341 cattle had died out of 770 attacked, or 44·3. The disease is said to have died out in November.

1870.

In the districts both of Unao and Lucknow cattle plague continued to prevail throughout the year 1870. In the former, the early reports concerned the Safipur Pargana, but during the last half of the year disease seemed to have spread all over the district. The murrain was called *haisa*—cholera—because purging was the most prominent symptom, but there can be no doubt that rinderpest was the main cause of sickness and mortality. In Lucknow the early reports concerned the Pargana of Bijnor. In the beginning of May this district was visited by the Commission, and rinderpest was found prevailing in and around Banthra, some 16 miles from the city near the road to Cawnpur.

Reports continued to come from different parts of this district up to December 1870, and it is evident from these that rinderpest, called cholera, dysentery or looseness, was spread widely over the district and caused very material damage. No information has been received from the District of Barabanki.

BENARES DIVISION.

The history of cattle disease in the North-Western Provinces is considerably more meagre than in Lower Bengal, but they both possess this feature in common, that the source of interest in the subject was the same, namely, a communication from the Madras Government, similar to that which has been noticed at page 38, giving a description of the outbreak of murrain in the District of Karnul of that Presidency, and enquiring whether anything of the same sort had been observed within the jurisdiction of the Government of the North-Western Provinces. This letter (No. 1934, dated 27th October 1863) was sent to the Sudder Board of Revenue on the 3rd of December, with a request that the Commissioner of Jhansi, in whose Division murrain had appeared in 1861-62, should be requested to furnish information on the subject, or "any other officer within whose jurisdiction distemper may have appeared." Dr. Pearson, Superintendent-General of Vaccination, was addressed separately on the same subject.

In reply to this communication, the Sudder Board of Revenue submitted (20th April 1894) papers regarding cattle disease in Dera Dun, Jhansi, and Lalatpur, which will be noticed hereafter. The reference to Dr. Pearson appears to have been without result.

Early in the year 1868 (17th January), the Government of India, in the Home Department, addressed the several Local Governments, calling for papers relating to cattle murrain, with a view to their publication in a volume of Selections. The documents above referred to were accordingly transmitted by the Secretary to the Government, North-Western Provinces (4th January 1868), and will be found at pages 200—204 of the *Selections "from the Records of the Government of India, Home Department," No. LXIX.*

In June of the same year the Commissioner of Allahabad submitted to this Government reports regarding cattle disease in the District of Banda which were subsequently forwarded (14th July) to the Government of India, and will be found in the same volume at pages 205—207.

Meantime, reports had been received by the Home Department regarding cattle disease in the Hardui District of the Province of Oudh in November 1867 (Selections, pages 194—199). Copies of these docu-

BENARES DIVISION.

Historical Sketch.

ments were forwarded to the Government of the North-Western Provinces on the 8th February 1868, with a view to ascertain whether a similar disease existed in these Provinces, and whether the abundance or otherwise of salt had any effect upon the health of cattle. This question was referred to the Board of Revenue, who issued a Circular, No. B., dated 27th March 1868, to all Collectors. This Circular elicited replies from all the Collectors of these Provinces, which were summarised by the Secretary on the 23rd July 1868, transmitted to the Local Government on the 22nd July, and to the Supreme Government on the 13th August.

These replies, which are printed in the Selections (pages 208—216), contain for most districts the earliest extant records on the subject of the diseases of cattle in them, and will be frequently referred to in these sketches. This account of the development of information regarding cattle murrain in these Provinces has been written here once for all, and will be referred to as occasion requires.

1868.

As regards the districts of the Benares Division, the Collectors of Benares, Goruckpur, and Mirzapur report that no cattle disease had appeared in their districts. Statements of this sort are to be understood as referring to known or reported cattle disease; for the personal inquiries of the Commission in all the localities visited by them disclosed, in these as in the Lower Provinces, a traditional or unrecorded history of cattle diseases, stretching back beyond the recollection of the present generation. This was notably the case with the Benares District, where oral testimony revealed the existence of cattle plague in the years 1849, 1855, 1857, and 1865.

The Collector of Bastí describes a plague which he calls *petbhagí*, whose symptoms were "languor, refusal to eat, diarrhœa, bloody stools, a swollen appearance, and sometimes maggot-infested lips," and which prevailed in the Bastí Tahsil adjoining the Faizabad District. This may have been rinderpest, but the number of cattle affected by it is said to have been small. In Bansí considerable cattle sickness prevailed in September and October 1869; eight different cattle diseases are said to be known in this district.

The Collector of Azimgarh also reports that a good deal of cattle mortality had occurred on the confines of the Faizabad District. It is worthy of note here that, as will be more fully shown in Appendix 4, a system of cattle poisoning was discovered in the Faizabad District in February 1869, and it is not improbable that this may have been in part the cause of the mortality noticed by the Bastí and Azimgarh Collectors.

The report from Ghazipur is more precise. Cattle disease had occurred in Pargana Zamanea, on the Shahabad side of the Ganges, which was investigated by a farrier from the Kairantadhi Stud, and pronounced to be a contagious typhoid fever—no doubt rinderpest. In the year 1869 cattle disease became a subject of great attention in Benares. It appears from the Proceedings of the Home Department (Nos. 172 to 174 of 21st August) that cattle disease appeared both in the district and among the Commissariat herd in the early months of 1869. It appears from a letter of Mr. M. Brodhurst, the Collector of Benares, that up to the month of March "there had not been a rumour of the existence of any cattle disease in the district." In a report to the Sudder Board of Revenue (dated 4th March) Mr. Brodhurst states that— 1869.

"A few months since there was some sickness and loss of cattle, but at present there does not seem to be any, except in two villages of the Benares Tahsil, where considerable loss is said to have been sustained amongst the cattle from a disease termed by the natives *chechuck* or *small-pox*. Reports were called for from the

BENARES DIVISION.

Historical Sketch.

Tahsildars, and as a result of these a village-to-village inquiry instituted. From these inquiries it appeared that the disease had broken out in October 1868. The Tahsildars had some difficulty in eliciting information from the people, but they found the symptoms of the disease to be,—hair standing on end, ears drooping, a sticky saliva from the mouth, distention of the stomach, frequent purging—first of watery, then of bloody discharges—and death in from one to nine days after attack."

The remedies used by the people are specified: *ghi*, the rind of *kodha*—a kind of gourd,—fomentation of the face with decoction of *nim* and pujas. The latter had been performed by chamars for money received. The Tahsildars were inclined to believe that many of the deaths were attributable to poisoning. Mr. Brodhurst goes on to say that on the 9th May he had seen cattle belonging to Rajah Sir Deonarian Singh, suffering in the neighbourhood of Benares, from symptoms similar to those above described. This, he remarks, could not be owing to poisoning because the chamars were not allowed to take the hides. The Raja had lost 13 cattle in Benares, and the same disease had broken out among his cattle on an estate near Syadpur, in the District of Ghazipur. The Rajah's cattle were of superior breed and lived under good sanitary conditions, and succumbed to the disease, while the weaker and comparatively worthless were not attacked, or if attacked, recovered. Cases of cattle poisoning had been brought to light in the district, and 27 persons had been punished for the crime within 6 months; arsenic being the poison used. In the adjoining District of Jaunpur the mortality, alleged chiefly from poisoning, had been very great during the preceding few months. The result of the village inquiries is shown in the statement at page 358, and the Collector surmises that the deaths had not probably exceeded one per cent. of existing stock. Proclamations had been issued enjoining segregation, and forbidding movement of infected cattle. While these inquiries were being prosecuted regarding the cattle of the district, disease had broken out among the Commissariat slaughter cattle in the military cantonments. The disease broke out on the 13th of March 1869 amongst a batch of cattle which had been purchased at the Kat Berhampur Fair, in the Shahabad District, on the 10th of February, and marched to Benares, arriving there on the 18th, 13 days before the disease broke out.

Four cattle died on the 13th March: these must have sickened some days before. The matter was reported to the Officer Commanding the Station on the 21st, and a special Committee was at once appointed "for the purpose of examining the cattle and taking such steps as might be necessary to check the spread of the disease." Veterinary Surgeon O. Barrow, of the 19th Hussars, carefully examined the cattle, reported that they were suffering from rinderpest, and recommended separation, the slaughter of diseased animals, burial, quarantine, and continued inspection. His letter is printed in full at page 360. Accordingly, 17 animals were slaughtered, the skins were destroyed, the carcasses buried, and the sheds thoroughly disinfected. The disease died out by the 27th. The slaughter cattle were carefully inspected by a Veterinary Surgeon, and the meat by a Medical Officer, and the strictest separation of sick and healthy enforced. The result was that in a stock of 230 head, 93 were attacked, 35 died, and 18 were destroyed. A second batch of cattle was bought at the same fair on the 10th of April, and marched to Benares, where they arrived on the 18th of April. They were inspected and found apparently healthy, and housed with the remaining cattle; disease, however, broke out among them on the 22nd, four days after the introduction of the new cattle. The disease died out on the 7th May after 77 had been attacked in a stock of

O. 551-594.

BENARES DIVISION.

Historical Sketch.

340, and 37 had died; 18 sheep were also attacked with similar symptoms and 9 of these died. The destruction of diseased animals was not resorted to on this occasion,—separation, cleanliness, and medical treatment (bleeding, purgatives and tonics) being the means employed to combat the plague.

Attention was now directed to ascertain whether disease had existed at the fair or along the road by which the cattle had marched. It was found that a similar disease had broken out among 130 cattle purchased at the same fair and marched to Dinapur: 10 died out of 30 attacked. The Collector of Ghazipur reported that a "contagious fever" had prevailed among cattle in February and April at two of the halting places, and it was subsequently ascertained from the Assistant Magistrate of Buxar that *sitlah* had broken out at the April fair and in some of the surrounding villages. All the correspondence summarised above was sent up to the Government of India, and the matter attracted the notice of His Excellency the Viceroy, who ordered an inquiry. A Committee was accordingly convened, consisting of Colonel Turner, Mr. Brodhurst, Collector of Benares, Dr. R. Cockburn, Civil Surgeon, Captain H. D. T. Chester, Deputy Assistant Commissary General, and Veterinary Surgeon E. Stanley, 5th Lancers. This Committee, after a careful investigation, came to the conclusion that the disease was rinderpest, and was endemic. They could not recommend "stamping out," but urged segregation and legislative action to that end.

While the evidence regarding the prevalence of disease in the Benares District in 1869 is so strong and clear, the information from other districts of this Division is scanty. In Jaunpur there was "very great loss of cattle" during the year. This was attributed partly to disease and partly to poisoning. There can be no doubt that both causes were in operation. The deaths were estimated by Mr. Daniell, the Magistrate of the District, at 12,000 head, and it is very difficult to say how many were due to one or other cause. The impression gained by the Commission during their visit to this district was, that disease was responsible for the majority of deaths, and that here, as in other parts, poisoning was practised under cover of the disease, and that when a few cases of the latter were discovered, the people were prone to attribute all their losses to a cause which satisfactorily accounted for some.

1870.

On the 25th of January 1870 the Collector of Benares reported that cattle disease no longer existed in the district. It was found, however, in April to be extensively prevailing, and in a return furnished by the Police, dated the 1st of May, 1,139 deaths are reported out of 1,388 cases—82 per cent.—probably an exaggerated statement. A careful local investigation was made by the District Superintendent of Police. Cases of poisoning were discovered, but the investigations satisfied the Collector that these were few in number, and even after stringent orders for burial were passed and enforced, deaths continued to occur as before. The reports of the District Officers are full of interest and are given in detail. Veterinary Surgeon Lemon, Royal Horse Artillery, accompanied the District Superintendent of Police into the district and studied the disease, giving directions for treatment. He found the disease so much milder in type than he had known it in England, that he at first doubted its identity with rinderpest. At the request of His Honour the Lieutenant-Governor, this district was visited by the Commission on the 30th of May. The disease was found to be prevailing in the immediate vicinity of the city of Benares, and cases were examined: the *post-mortem* examinations made, and evidence taken, convinced them that it was the same form of disease which they had previously met with, namely, rinderpest, an

BENARES DIVISION.

Historical Sketch.

opinion in which Mr. Lemon, after reconsidering all the evidence upon the subject, concurred. The disease in this district appears to have died out about this time, and no subsequent reports were received. The District of Jaunpur was visited by the Commission early in June, for the purpose of inquiring into the subject of cattle poisoning. Efforts were made to discover the existence of disease, but without success. Cattle disease prevailed in the Ghazipur District in July and August, but not in a severe degree, and seems to have been put a stop to by a heavy fall of rain.

The Magistrate of Azimgarh reports the prevalence of *chechuck* in some tahsils of the district in April, May and June. The information given is meagre.

In the District of Bastí cattle disease is well known, and both rinderpest, (*bhowani*, etc) and foot and mouth disease are said to exist. The latter prevailed in August towards the north of the district. Hoven appears to be a common disease in the district, caused by improper feeding, and called *parbhaghí*, etc.

In Mirzapur disease prevailed extensively from March to November. The disease prevailed in 125 villages of Parganas Kuntil, Chunar, Robertsganj, and Barhar, the greater number of the villages being included in the latter. The diseases are called *sítlah*, *rangwa*, and *batass*. In a stock of 347,754, 33,250 cattle are said to have been attacked —9·56 per cent. of stock; 10,705 to have died—3·07 per cent of stock, and 32·19 per cent. of attacked; and 22,545 to have recovered. The diseases are pronounced infectious. *Sitlah* appears to indicate rinderpest, and as the symptoms are not clearly distinguished, it is difficult to know what the other two names represent.

In the District of Gorackpur no official report of prevailing disease was received; but from a private letter received by a member of the Commission, it appears that both foot and mouth disease (*khang*) and rinderpest (*chechuck*) are well known, and prevail yearly Other diseases are mentioned, which it is impossible, from the imperfect descriptions given, to identify, but hoven (*bhaghí*) is among them.

ALLAHABAD DIVISION. 1868.

The earliest written record of cattle disease in this Division concerns an outbreak in the District of Banda in the year 1868; but the oral testimony of the inhabitants of Hamirpur, Cawnpur, and Fatehpur, obtained by the Commission, is to the same effect here as elsewhere, namely, that murrain has always prevailed from time beyond memory. The Banda disease broke out in February. The Collector, Mr. M. Sandys, reports in May that 1,310 head of cattle had died. The disease broke out in Pargana Tirohan, but it spread widely over the district.

In one mouzah of the Banda Pargana, 48 recoveries out of 62 cases are reported. In a later communication (16th of June), the mortality is put down at 2,461 out of 5,035 attacked—48·8 per cent. The disease was said to have been imported from Independent States adjoining the district; but the Collector points out that this could not be true of the Tirohan and three other parganas. Strict injunctions had been issued to isolate all diseased animals and prevent communication. The disease was declining.

Mr. Sandys writes again in August. He describes the symptoms of the murrain thus:—"At first languor, refusing to take food or water, prostration and fever; then, on the third or fourth day, liquid and bloody stools, which continue with greater frequency till the death of the animal —generally on or about the seventh day." Sometimes the fatal issue was more rapid. No successful treatment was known, the natives giving split gram soaked in water. Mr. Sandys writes:—"Since the outbreak

ALLAHA DIVISI

Histo Sketc

the disease has appeared in 99 villages in this district. The total number of cattle attacked has been 6,536, and total number of deaths 3,365; nearly 50 per cent. therefore have recovered."

He also describes *khura*, foot and mouth disease, which prevailed consentaneously. A memorandum by Dr. Ringer is appended, in which sulphur fumigation is recommended. Dr. Ringer had performed a *post-mortem* examination, and found the intestinal mucous membranes much congested.

The replies forwarded by Collectors to the Board of Revenue's Circular No. B show that no disease was known to exist in the Districts of Jaunpur, Fatehpur, and Cawnpur. From Banda the information above summarised is given. Cattle disease prevailed in Pargana Barali of the Allahabad District and its neighbourhood; up to 29th April 1868, 368 cattle had died. The symptoms described are—"loss of appetite, discharge from mouth and nose, and eruptions." Segregation was recommended. In the Hamirpur District a disease similar to the Hardui disease had broken out, but the mortality was not great.

The year 1869 was one of great drought and scarcity of fodder in the North-Western Provinces. A very great number of cattle died in the Allahabad Division from this cause alone; but in the Districts of Hamirpur and Jaunpur disease also prevailed, and carried off the impoverished cattle in great numbers. The evidence regarding it is stronger in the Hamirpur District than in the other. The Collector, Mr. E. B. Thornhill, gives a good account of the murrain in reply to questions propounded by the Government of the North-Western Provinces. He states that the disease is always present in the district, but more prevalent in some years than others. In 1869 it commenced towards the end of the cold weather and continued into the rains. It spread all over the district. The mortality is put down at 15,598, and the symptoms are well described. **1869.**

The evidence collected by the Commission on the occasion of their visit to Hamirpur in April 1870 confirms this account of the disease in every particular. The Collector of Hamirpur subsequently forwarded to Government a careful return of mortality, which, with the Commissioner's comment, is printed below.

The mortality among cattle in the Jaunpur District was undoubtedly very great, and was mainly attributed to poisoning; but there can be little doubt that both starvation and disease had much to do with it. A good summary of facts concerning loss of cattle in this district is given in Mr. Crosthwaite's letter printed at page 362, and much more will be found in Appendix No. 4. Banda appears to have been free from disease during 1869.

During the year 1870, however, both rinderpest (*chechuck* or *bhowani*) and foot and mouth disease (*khura*) appear to have prevailed throughout the district. These diseases prevailed also in the Sub-division of Kirwí. The mortality is put down in the District of Banda at 583, and in Kirwí at 198. **1870.**

The District of Hamirpur was visited by the Commission towards the end of April, and much valuable evidence was obtained regarding the past outbreaks; but, notwithstanding a searching inquiry, no cases of rinderpest could be found in the neighbourhood of the station. Foot and mouth disease prevailed there at the time, and rinderpest was said to exist in the western part of the district. In the town of Cawnpore also, and its vicinity, careful inquiries were made as to the present and past existence of murrains. Foot and mouth disease was found to prevail

ALLAHABAD DIVISION.

Historical Sketch.

among the Government cattle. The people were familiar enough with the usual diseases of cattle, but no exact information regarding recent or present disease could be obtained.

From Fatehpur, reports of an outbreak of disease early in March were received in May. The district was visited on the 21st of this month, and many cases of rinderpest—*debi*—were seen, and evidence recorded showing that the disease was no new one in the district. Subsequently, a report of a severe outbreak of disease in the Ekdala Pargana of this District was received in September. The disease had broken out in July and lasted till the middle of August; mortality 140. The symptoms recorded are so vague as to leave some doubt as to what the nature of this disease was.

The Commission also visited the Jaunpur District early in June, in order to investigate the system of cattle poisoning said to be rife there. Inquiries were also made with regard to disease, and the usual information was obtained—that rinderpest and foot and mouth disease were well known, and visited the district periodically: no case of either was found, though they were carefully sought for.

In August, a report of the prevalence of murrain in the Pur and Manjanpur Muzahs of Pargana Cheyal of the Allahabad District was received. A Native Doctor was deputed to investigate the nature of the disease. Subsequently, disease was ascertained to exist in the Karah Pargana, and on the 1st of September some cases were reported to have occurred in the Station of Allahabad. It appears from the reports received that both foot and mouth disease and rinderpest prevailed simultaneously. The report of the Native Doctor refers unmistakeably to the latter, while the Police Officer who investigated the disease describes the former. The last report from this district is dated 6th October. The disease was still going on; but from the fact of no subsequent reports having been received, it is inferred that it died out or continued to prevail mildly.

AGRA DIVISION.

The information regarding cattle diseases in this Division is meagre. No written record exists prior to 1868, though the oral evidence obtained by the Commission tells the usual tale of periodical prevalence for very many years.

1867-68.

The replies to the Board's Circular B contain the earliest information on the subject. Both in Maínpurí and Etah, cattle disease, similar to that observed in Hardui, in Oudh, is reported to have prevailed in the cold weather of 1867-68. In Maínpuri the disease broke out in October, and its symptoms were—refusal to eat, followed by much diarrhœa and fever, apparently with great thirst, exhaustion, and death about the third or fourth day. This is what the experience of the Commission has taught them to call rinderpest. Goats and sheep are also said to have suffered much. In Etah the disease broke out about the close of the rains. It was considered contagious. The loss was roughly estimated in the Etah Tahsil at five head per village. Sheep and goats also died in numbers. In Agra, Etawah, Farackabad, and Muttra no cattle disease had been observed.

The next official record of cattle disease is a report from the Farackabad District, dated 21st February 1870. From this paper it appears that murrain had been prevalent in the district during the two previous years. The symptoms are vaguely stated, and the mortality noted was probably owing to more than one form of disease.

1868.
1869.
1870.

In the month of March 1870 murrain broke out in some parts of the Etawah District. It was called *rog*—plague, and the symptoms were those of rinderpest. On the 15th May the village in which disease was

AGRA DIVISIO[N] **Historic[al] Sketc[h]**

reported to exist was visited by the Commission. Disease was found to exist there and in many neighbouring villages and to have prevailed in other adjoining parts of the district. The people spoke of it as a familiar and frequent visitant.

The District of Agra had been declared free of disease. The city was, however, visited on the 17th May, and careful inquiry and inspection of cattle resulted in the discovery of three cases of rinderpest, and this disease was also found to be prevailing in some of the villages in the vicinity. The sickness and mortality had not been so severe as to attract the attention of the Civil authorities. The same tale of periodical prevalence was told here as elsewhere.

A report from the District of Etah, dated 20th August 1870, showed that *bedun* (rinderpest) was prevailing at that time. Other diseases of cattle—among them, foot and mouth disease—were said to be of yearly prevalence.

On the 16th of September the existence of a plague "of a virulent kind" was reported. The symptoms assigned to it point to a severe form of rinderpest.

On the 18th of October the disease was abating. The mortality is put down at 1,384.

No further report was received from this district.

The Collector of Mainpuri reported in August that there was no disease in his district.

From Muttra a report was received in November to the effect that cattle murrain occurred in the district every year, but no specific information as to locality and mortality was given. Foot and mouth disease and *matah* are mentioned as well-known diseases.

MEERUT DIVISION

The earliest account of cattle murrain in this Division is that furnished by F. Williams, Esq., Superintendent of Dera Dun, who writes in March 1864. After describing the disease called *burra rog*, which, he says, resembles the Madras disease, and detailing the symptoms, which are those usually referred to rinderpest in this country, he states that the disease appeared in the Dun and Jaunsar Bowur in 1862. In the same year a similar disease broke out among the elephants in Dera and proved very fatal. Another disease called *rorah* is also described, to which the symptoms known to belong to foot and mouth disease are assigned. Both diseases are considered contagious, and the natives thought that they had got worse of recent years, owing to crowding and massing cattle together; accordingly, when disease appeared, they drove their cattle as far into the jungle as possible. Information of more recent date is contained in the replies of the several Collectors to the Board of Revenue's Circular B. The Superintendent of Dera Dun reports that the disease prevailed in 1867 in two villages, one in Eastern and one in Western Dun. The same symptoms are assigned and the name *waha* given. Well-conditioned cattle are said to be more liable to attack. He states again that the people practise segregation.

1862.

1867.

The Collector of Saharunpur reports that the cattle disease called *sir*, *rorah*, or *rorh* had been "unusually virulent" in his district during the latter part of the rainy season The mortality as given by the Tahsildars is marginally quoted, but the Collector does not place much reliance upon their statements. The disease had spread all over the district, and the Collector was aware of its existence for years past.

Tahsils.	*No. of deaths.*
Saharunpur	2,499
Rurki	2,269
Deoband	12,408
Nukur	7,700
Total .	24,876

OXEN. | Selections from Report of Indian Cattle

MEERUT DIVISION.

Historical Sketch.

The Collector of Mazafernagar states that disease generally occurs towards the close of the rains. The symptoms described are those of rinderpest. In October 1867 about 10 per cent. of the cattle of the district died.

The Collector of Meerut states that *rorah*—foot and mouth disease—is the only form known in his district. He, however, gives under this name some of the symptoms belonging to rinderpest. The disease, he says, is infectious, and prevails from August to the end of September. In 1867, in one village of Barnawa Pargana, 200 cattle died in two months. He also mentions that in 1866 large numbers of sheep had died of a distemper, the nature of which he did not know.

The Collector of Bulandshahr states that from November to January cattle suffer from " a species of influenza accompanied by diarrhœa." The Collector of Aligarh states that there has been no cattle disease in his district.

The next series of reports regarding cattle diseases in this Division was elicited by the circulars and queries of the Commission. The districts of Meerut, Bulandshahr, and Saharunpur were also visited by the Commission and much valuable information thus obtained.

1870. In May 1870 the Collector of Meerut reported that foot and mouth disease had prevailed in March. In June the Tahsildar of Haupper reported that disease had broken out a month before in the village of Dhanowra; the symptoms described are those of rinderpest: 10 cattle had died in the village. This village was visited on the 28th of July, and satisfactory evidence was obtained regarding the present and past prevalence of rinderpest. In August another report was received from this district regarding a village, Pirnagar, in the Garmuktesar Pargana, in which rinderpest had prevailed for 15 days. On the 28th of April the Collector of Bulandshahr forwarded a return showing that cattle disease was very prevalent in the district.

This disease was called *khurpucca*, but the description of it and the mortality attributed to it showed that many of the cases must have been cases of rinderpest. This surmise was verified by the Commission on the occasion of their visit to the district in July. Fortnightly returns of the prevalence of both diseases have been regularly received since then up to the 15th December 1870; both these diseases appear to have been prevalent throughout the district, and the Collector has attached greater credit to the later than the earlier figures furnished by his subordinates in the Revenue Department.

Disease was also widely prevalent in the Saharunpur District during this year. It appears to have commenced as early as December 1869 in some villages, and a return furnished by the Collector on the 3rd of August shows its prevalence in 22 villages of the Parganas of Rurki, Jowalapur, and Nalur. Two forms of disease are specified—*maind* or rinderpest and *sedh* or foot and mouth disease; but in the returns the two forms are evidently mixed up together, and their value is accordingly much impaired. They show a mortality of 1,184 in a stock of 10,746, or 11 per cent. The principal symptom assigned is dysentery. This district was visited by the Commission on the 2nd August, and the disease *maind* or *rorah* identified as rinderpest. Several cases were examined and animals examined *post mortem*.

The Collector of Aligarh reported (11th July 1870) that the diseases *khurpuccaa* and *mupucca*—foot and mouth disease—prevailed in the Parganas of Chandaus (9 villages) and Khair (11 villages) in the Khair Tahsildari, in the north-west of the Aligarh District, since the end of May 1870. In a stock of 2,075, 1,535 cattle had been attacked (74 pe

O. 551-594.

MEERUT DIVISION.

Historical Sketch.

cent.); 369 had died (17 per cent. of stock and 24 per cent. of attacked); 1,166 had recovered.

The disease was considered infectious, and the symptoms assigned are a mixture of those of rinderpest and foot and mouth disease, showing that both forms prevailed simultaneously.

The disease was reported to have disappeared on the 22nd of July.

A careful report on the subject of cattle diseases in the District of Muzafernagar is printed in the sequel, showing that both rinderpest and foot and mouth disease are well known in the district and frequently prevail.

The Superintendent of Dera Dun, in a letter, dated 25th November 1870, describes *baraduk*—rinderpest—and sore feet as the diseases of cattle known in that district.

ROHILKHAND DIVISION.

The earliest information from this Division is that contained in the replies to the Circular of the Board of Revenue (No. B, dated 27th March 1868). These represent more prevailing cattle murrain than the replies from any other Division.

1867-68.

The Collector of Bijnor describes a virulent murrain which raged in his district during the cold weather of 1867-68. It was most common in the Forest Parganas of Barapura and Afzalgarh, and along the Ganges Kadir, but was not confined solely to these localities. It was known by the names *bedun* or *chera*, and was believed to be contagious.

The mortality was stated from different places to have been one-half, two-thirds, and three-fourths. The symptoms assigned are a mixture of those of rinderpest and foot and mouth disease. The treatment, also, is partly that employed in foot and mouth cases—poultices of the leaves of *kikur*, *kuchnar*, and *ag*, and in rinderpest—cakes of peas or rice flour soaked in oil.

The Collector of Moradabad reports that in September and October (1867) there was some mortality among bullocks and cows. The disease was similar to that which had occurred in the Hardui District, in Oudh—rinderpest. The mortality was great, and it prevailed mainly among the herds of the Tarai and Ganges Kadir.

A special report from the Superintendent of the Tarai Parganas tells a tale of great mortality. Disease commenced after the rains, and continued till the latter end of January 1868. The returns collected showed that in a stock of 46,880 head of cattle, 12,221, or 26 per cent., were attacked; and 8,912 died, or 19 per cent. of stock and 73 per cent. of attacked. The symptoms are described briefly as intense thirst followed by bloody stools. The animal generally died on the third or fourth day after its attack. The disease is stated to be *no new one*, and is called *chera*. Isolation was practised, and the cattle of the Tharu population, who take better care of their cattle, were not attacked.

The Collector of Budaun states that the disease described in the Hardui District is a very common one, and called *bedun*.

The Collector of Shahjehanpur states that the disease appeared in some villages of the Pargana Jellalabad from August 1867 to January 1868.

The Collector of Bareli reports that no such disease had appeared in his district. Murrain was at this period, therefore, well known and very rife in this Division; and it is interesting to find that here, as elsewhere, its ravages are most marked among the herds upon the grazing grounds of the Tarai.

In December 1868 a severe outbreak of disease occurred at Amsote, in the Bijnor District, among the heads which were driven to graze there, owing to the drought elsewhere. An establishment was entertained

ROHILKHAND DIVISION.

Historical Sketch.

1870.

for the purpose of preventing the spread of the disease by segregation, and the result appears to have been favourable, the disease having disappeared in January.

Disease was again reported to exist in the same grazing grounds at Najibabad, towards the north-west of the district, in September 1870. The form on this occasion was *pukka* and *chupka*. Other diseases had also prevailed in the jungles, and deaths had been numerous : rinderpest—*bedun*—was no doubt the chief cause of them.

In the District of Shahjehanpur cattle disease prevailed during the first half of the year "in almost all the parganas and villages of the district."

No precise account of this prevalence has been received but the names and features of the diseases given show that both rinderpest and foot and mouth diseases were among them.

In August 1870 the Collector of Bareli reported that disease—violent diarrhœa and great thirst—had broken out in and around Muza Ukka, Pargana Asald. The disease was *bedun*, and had broken out two months previously. In Ukka alone, in a stock of about 1,000 cattle 225 are said to have been attacked (22·5 per cent.), and 200 to have died (20·6 per cent. of stock and 91 per cent of attacked). The disease was considered infectious.

On the 15th of August this disease broke out among the Commissariat slaughter cattle in the town of Bareli. Measures of segregation were immediately adopted. The affected cattle were removed and the unaffected divided into five lots, and kept apart at convenient distances; 55 were attacked and 32 died (58 per cent.), the disease dying out on the 25th August. Hitherto the symptoms had been those usually observed, violent purging, etc., but on the 20th the type changed : 27 cattle were attacked with a breaking out over the body, accompanied with constipation of the bowels This change in symptoms is ascribed to the cattle being fed with dry *bhusa* instead of green grass; of the latter disease, 4 died; the remainder were treated by Dr. Corbyn, and with apparent success, with laxatives, and sulphur ointment externally.

Colonel Mills attributed the outbreak among the Commissariat cattle to infection by the sick cattle of the town of Bareli, which were in the habit of grazing within cantonment bounds. No subsequent report was received from this district or station.

The Collector of Moradabad reported in August that foot and mouth disease had prevailed in the district since March, more particularly on the borders of the Tarai. He subsequently reported that in 60 villages of one pargana, among 24,036 head of cattle, 811, or 3·3 per cent., had died during the previous 6 months; among 15 attacked, 8 recovered and 7 died. This looks an enormous mortality from foot and mouth disease; but the Collector explains that more probably only severe cases of illness were entered among the sick.

A subsequent letter, dated 21st October 1870, shows that, as a result of a careful local inquiry, disease was found to be widespread in the district. Mr. Daniell appends to this letter a return embracing statistics of 29 out of 250 villages in which disease had been found to exist, and where it had been most severely manifested.

A report from the Collector of Budaun, dated 2nd September 1870, stated that in June the cattle of that district had been affected with both *pukka*—foot and mouth disease—and *bedun*—rinderpest. The evidence above summarised is thus conclusive as to both these forms of disease prevailing frequently, and sometimes with great severity, in all the districts of this Division.

Plague Commission, 1871. (*H T Pease.*) | **OXEN.**

KUMAUN DIVISION.

Historical Sketch.

The Commissioner of Kumaun states, in his reply to the Circular of the Board of Revenue, No B, dated 27th March 1868, that "cattle disease is as well known in Kumaun as small-pox among human beings" The disease is called *man*, and comes every year When it comes regularly, it is less fatal, but when two or three years have elapsed, it appears in a very virulent form, this *man* only attacks cattle once, and a *mantuar* bullock or buffalo is much more valuable than one that has not had *mán* The disease is considered contagious, but no attempt is made at separation This is not a result of apathy, but from a belief of the people that an animal must get the disease, and the sooner it gets over it the better *Man* is considered identical with the Hardui cattle disease described by Dr MacReddie and is said to have been "known in the hills and Bhabar forests *from of old*, it is even known in the Snowy Range, and sometimes carries off large numbers of *jubus* (a cross between the cow and yak); but in such cases the disease is believed to be taken up by the Bhutea traders from the lower country" This fits into the evidence collected at Darjeeling concerning the prevalence of disease among the cattle of Nepal and Thibet, and is further confirmed by information obtained from Dr Wright, Residency Surgeon at Katmandu Horses, sheep, and goats it is further stated, are not known to be attacked by *man.*

The local officer at Kumaun states that the cattle of the eastern parganas have been suffering severely from this disease.

The information from Garhwal is to the same effect. *Man* had been prevailing from October 1867 to January 1868 in the Bhabar forests of the district about half of the affected cattle are said to have died.

The only information obtained from this Division in addition to the above is a letter from the Commissioner of Kumaun, dated the 28th July 1870, in which it is stated that no disease prevailed at that time, but that *man* comes every year and has been always known in that part of the country. There can be little doubt that this *man* is rinderpest, and it is to be remarked that foot and mouth disease is not mentioned in these reports **1870**

Central Provinces.

CENTRAL PROVINCES.

General Summary.

An isolated notice of cattle disease at Saugor in 1830 exists in a report on vaccination by Mr Campbell, Superintending Surgeon, who says:— "It is worthy of remark that during the prevalence of the epidemic (small-pox) in this district, great numbers of cattle died of a disease which the natives distinguish by the same name which they use for variola, namely, *matah.*" This note is interesting as showing that, though detailed descriptions of murrains do not exist until very recently, there can be very little doubt of their prevalence before particular attention was directed to the subject. In the absence of any data on which to found a historical statement, it is thought better to prepare the following précis of information which has accrued within the last few years, according to the divisions of the province The sources of information are, *1st*, short notes in the weekly returns of rainfall published in the *Central Provinces Gazette*; and *2nd*, the replies from District Officers, elicited by the Commission's letter No 372, dated 14th June 1870. **1830**

NAGPUR DIVISION—(Districts *Nagpúr, Bhándára, Chándá, Wardhá,* and *Bálághat*)—Cattle disease was noted as prevalent in the Nagpúr Tahsili of the Nagpúr District in December. **1867.**

Cattle disease prevailed slightly in Nagpúr in January and again in July. In Bálághát, Taluka Badra, in January, April, and May, and in Chándá (Rajgarh Pargana and Mhul Tahsili) in February, March, and April. **1868**

OXEN.	Selections from Report of Indian Cattle

CENTRAL PROVINCES

Historical Sketch.

General Summary.

1869.

1870.

Foot and mouth disease (*chankhurah*) was reported to prevail in the Mhul Tahsil of Chándá in April. Cattle disease was again reported in the Rajgarh Pargana of Chándá in September.

Cattle disease was very prevalent in the Chándá District throughout the year. In April it is reported to have appeared in the Barhampuri Tahsil, and subsequently in the Mhul Tahsil. It is reported as continuing to prevail in May and June, and towards the end of June has appeared in the Warora Tahsil. During July it is said to be on the decrease. On August 6th it is noted on the increase in Mhul, especially among buffaloes. The disease continued to prevail throughout August, September, October, November, and December, in which month a decline is noted. The name of the disease is not indicated.

Cattle disease also prevailed in the Bálághát District. In April foot disease was reported. In May small-pox broke out in the Sangí Pargana and Kionapur Taluka. In June the disease is noted as continuing. In July it is said to have broken out among the cattle in the north of the Dhansoa Pargana. In the beginning of August it is noted as spreading; towards the end of the month it is noted as very prevalent and fatal. In September disease is said to be decreasing, and later on in the month to have nearly disappeared. In October and November "foot rot" is noted as prevailing in the Paraswara Tahsil.

The Commissioner of Nagpúr reports in his letter, dated 6th September 1870, that the bad diseases of cattle known in the Division are "small-pox," known as *matah* or *marai*, and *khurí*, foot and mouth disease. "Sporadic cases of the former occur from time to time in every district; but every four or five years the disease becomes epizootic and carries off a large number of cattle." The symptoms described by Mr. Ramaswamy are,—at the first a flow of tears from both eyes, low spirits, and then purging; death takes place in from three to five days, and the mortality is put down at 75 per cent.

1869. Jabalpur Division—(Districts *Jabalpúr*, *Sagur*, *Dumoh*, *Seoni*, and *Mandla*).—Cattle disease is reported from Sagur in August, September, and October.

1870. In September cattle disease (*bhonda*) is reported among buffaloes in some of the Khorai villages of the Sagur District. The prevalence of this disease is again noted in October. A sudden outbreak of "cow-pox" and disease of the hoof at Naraingunj in the Mandla District and the neighbouring villages is reported in August 1870. In the report for the week ending 1st October the following information is given:—"At Ramgarh, early in September, 10 cattle were attacked with the disease called *patahna*—all fatal; no fresh cases at Pindrai. Fourteen head of cattle were fatally attacked with a disease called *ghat sarfal* (swelling of the neck) on 31st August, and 5 more on 24th September: no fresh cases." On 8th October it is noted that "12 head of cattle were fatally attacked by the disease called *gondha*, or cough, at Bijanra on 25th September; of these 2 died and 10 recovered; no fresh attack since. At Deolapúr 10 cattle were attacked with the above disease; 5 recovered and 3 died; no fresh cases." On 22nd October it is noted that at Dadha 12 cattle were attacked with cow-pox; 3 died and 9 recovered. At Kundra 25 head of cattle died from cow-pox: no fresh cases. Again, on 5th November, it is reported at Shopura, "30 head of cattle were attacked with a disease—name unknown; they throw up water and are suffocated; 20 died and 10 recovered."

The Commissioner of Jabalpúr gives a summary of information obtained from District Officers.

Jabalpúr.—*Chechack* or *matah* prevailed during the rainy season of

1869, also *patakna*; the former is evidently rinderpest, and in the latter there is giddiness and swelling of the throat: ⅓rd or ¼th of the cattle of the district are said to have been carried off.

Under date 19th October 1870, the Deputy Commissioner reports the prevalence of these diseases in Tahsilí Murmara of the Jabalpúr District.

Sagur.—Two diseases called *ghorka* and *surka* prevailed in 1869. The former seems to be rinderpest, and the latter pleuro-pneumonia.

Dumoh.—Epizöotics occurred in 1865-66-68-69, names,—*bhowra, sohagpur, baikra,* and *chechack.* The latter two seem to be rinderpest.

Seoni.—No epizöotic disease prevails.

Mandla.—An elaborate tabular statement is forwarded, showing that cattle disease prevailed extensively in the years 1869 and 1870. The following is a summary of it:—*Poka* prevailed in 1869-70 in Talukas Tholpur, Niwari, Manfi, Inpli, Burhars, Pandaria; symptoms,—"the skin becomes scurfy and falls off, the saliva is excessive, and the bowels are severely purged;" duration four days; mortality,—in 1869, 704 died of 748 attacked; 1870, 53 died of 60 attacked.

Ghurka prevailed in 1869-70 in Talukas Sagur, Manfi, and Bambini; symptoms,—the neck becomes swollen, the head is in constant motion, and the animal refuses to eat and drink; duration three days; mortality,—in 1869, 56 died out of 62 attacked; 1870, 47 died out of 60 attacked. *Brynga* prevailed in 1869 in Talukas Mutfurkat, Mudmi, Madequite, and Bijeygarn: symptoms,—gradual wasting away; duration, four months; mortality,—573 died of 901 attacked. *Matah* prevailed in 1870 in Talukas Gopi, Mutfurkat, Mudmi and Indra: symptoms,—the animal becomes sluggish, the eyes close, blisters then appear; duration, three days; mortality,—127 died of 260 attacked. *Khura* prevailed in Talukas Ramnagar and Ghugri in 1869-70; symptoms,—the hoof gets sore; mortality,—in 1869 14 died of 165 attacked; 1870, 119 died of 211 attacked. *Naksurka* prevailed in 1869 in Taluka Sufti: symptoms,—"head in constant motion, salivation;" duration, three days. The liver is said to be found inflamed and full of water *post mortem*; mortality,—10 died of 15 attacked.

Byha prevailed in Taluka Mutfurkat in 1869; symptoms,—the animal after two days' illness becomes mad and furious until it dies; mortality,—3 out of 7 attacked. *Chupka* prevailed in Taluka Ghugri in 1869-70: symptoms,—"there are ulcers on the tongue;" duration four days; mortality,—1869, 23 out of 166; 1870, 15 out of 134. *Pokní*, diarrhœa, prevailed in Taluka Ghugri in 1869-70; mortality,—1869, 6 out of 78; 1870, 18 out of 62. *Chechack*, cow-pox, prevailed in the same taluk in 1869-70; mortality,—1869, 7 out of 90; 1870, 4 out of 80; also *bhowra*, swinging of the head; mortality,—no death in 40 cases in 1869, and 5 deaths in 60 in 1870. From the above it is evident that rinderpest and foot and mouth disease are common in the district; the soil does not seem to make any difference as to the prevalence of the disease.

The other diseases seem to be owing to improper diet and to hydatid cysts. The deaths from all diseases amounted in these two years to 1,823.

1870.

Narbada Division—(Districts *Betul, Chindwara, Narsingpúr, Hoshingabad,* and *Nimar*).—Cow-pox is said to have prevailed in a few villages of Chindwara in September. Cattle disease existed in some villages of the Chamoar Patha Tahsil of the Narsingpúr District in October, and a few cases of cow-pox are reported in the same Tahsil in November.

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CENTRAL PROVINCES.
Historical Sketch.
General Summary.
1869.

In Betul disease is said to have prevailed slightly in June.

In Chindwara no general disease is said to have prevailed since 1848. Seven diseases of cattle are described by the Deputy Commissioner, namely, *maindh* or *kukera*, *gurgura*, *panpriah*,—nature unknown; *matah* and *marrí*, rinderpest, *bhowra* or *chucker*, and *tarack phasí*,—nature unknown.

In Narsingpúr small-pox is said to have existed in May and June 1869, and foot rot at various times. These diseases also existed in 1870.

In Hoshangabad cattle disease (rinderpest, foot and mouth disease, and pleuro-pneumonia) existed to a great extent in 1869 and 1870; disease is said not to have existed in Nimar of late years.

1868.

CHATTISGARH DIVISION—(Districts *Ráipúr*, *Sambalpúr*, and *Bilaspúr*).—Cattle disease broke out in the Mungailí Pargana of the Bilaspúr District in July, and was then carrying off large numbers; it continued to prevail in August, September, and October.

1869.
1870.

In October the disease broke out among the cattle in some villages of the Seorinarain Tahsil. It continued to prevail till December. In January it was prevalent in the Mungailí Pargana. In August about 200 cattle died of foot rot and small-pox in the Seorinarain Tahsil. In September its prevalence is noted in the Bilaspúr Tahsil and was again noticed in the Seorinarain Tahsil in October.

The Deputy Commissioner of Ráipúr states in the appended letter that during 1868 and 1869 cattle disease has been very virulent, and that about a third of the district stock was lost. The disease also prevailed during 1870. He describes *matah* (rinderpest), *sawmha* (swelled throat), *bupra* (nature unknown), *chhye* (rinderpest), *khura* (foot and mouth disease), also *phurtri* (mouth disease); 13,466 cattle died in 1869-70.

The Deputy Commissioner of Sambalpúr reports that epizöotics always prevail in the district; cattle disease prevailed in 1869-70. He describes *matah* (rinderpest), *khura* (foot and mouth disease), *cherra* (rinderpest), and *sahosa* (hoven). He estimates the deaths at 2,000 within the last year.

1868.
1869.
1870.

UPPER GODAVERY DISTRICT.—Cattle disease was reported in the Seroncha Taluk in December 1868 and in January 1869. In November a few cases of foot disease occurred. In May 1870 some cases of cattle disease occurred.

PANJAB.

The instructions of the Government of India (page 1) regarding the conduct of the inquiry into cattle murrains in Bengal did not originally indicate the Panjab as a field of observation or research. Reports were, however, received, more particularly regarding the districts of Gujranwala and Jhang, which showed that most serious losses by murrain were frequently sustained in this province. The reports, moreover, gave such a meagre and imperfect account of symptoms, that the diseases causing such wholesale havoc among cattle could not be identified. It was stated, for instance, "that no animal once attacked recovered; they languish sometimes for months, but surely die." This was so contrary to the experience of the Commission that it was felt that nothing short of a local inquiry could satisfactorily determine the nature of the murrain, or enable the Commission to suggest means by which its ravages might be limited. Government was, accordingly, addressed, and permission was readily accorded to visit the Panjab. This was done in July and August, and a large mass of information was obtained which satisfactorily solved the problem of what these destructive murrains were. It was found that pleuro-pneumonia, called by the natives *phiprí*, was a well-known and frequently-occurring disease of cattle, and had been known from time immemorial. Cases were seen, *post-mortem* examinations performed,

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PANJAB.

Historical Sketch.

and evidence led, which placed this on a basis of certainty. Another disease, very fatal in character, called locally *bhukni*—a very intractable form of diarrhœa—had caused great losses of stock in some districts, Gujranwala and Jhang especially. This disease attacks cattle at the latter end of the hot season, when pasturage is hardly to be obtained and the water is scanty and foul. At such a time the half-starved and debilitated cattle are doubtless attacked with diarrhœa, from eating rank or acrid herbage and plants, and drinking foul water.

During the rains and cold weather the pasturage in the Panjab is generally abundant and very good, and at these seasons the disease *suth*—quarter-ill or black quarter—is not infrequently met with among cattle.

Rinderpest, under the local names of *pir, vair, vah, vedun, sirah, bedun, mah, man, mowah, bara rog, sitlah, matah, andar-ka-matah,* etc., is unfortunately as well known here as in other parts of India. Ample evidence was obtained of its actual existence in different parts at the very time of the Commission's visit. Cases were seen and examined, and *post-mortem* examinations performed, which placed this beyond doubt; and the oral testimony of the inhabitants (who were always found to be most frank and open in their interviews and dealings) shows that rinderpest has occurred in the province from time beyond recollection. Foot and mouth disease, called *dhaka, kurag-murag, laru, khura, khura phata,* etc., is also to be found among the cattle in every district. Another affection of cattle was also found to be very prevalent among cattle, namely, cystic disease. This malady has such an intimate relation to public health that the fact that cattle are, in different parts of the Panjab, to a large extent affected by two forms of immature tapeworm—found in the flesh (**tænia mediocanellata**), and viscera (**tænia echinococcus**)—cannot be too strongly put forward. Neither of these diseases can properly be called murrain, and they are more important as liable to cause directly a loathsome, or indirectly a fatal, form of disease among consumers of beef, than as diseases of stock, though there can be little doubt that, even putting the use of cattle as food out of consideration, the serious impairment of the functions of their liver, lungs, and spleen, in consequence of their being occupied by large cysts, or of their muscles by small cysts, must debilitate cattle and render them less fit for work than they otherwise would be. An interesting paper on this subject by Surgeon-Major J. T. C. Ross, F.R.C.S., will be found at page 482, which gives a succinct view of the sanitary bearings of this question. This paper rather refers to the muscle cyst, but the hydatid cyst is more common. It was found by the Commission in Lahore in 11 out of 13 carcasses, and Dr. J. Cleghorn shown that in Multan 899 out of 2,109 cattle slaughtered by the Commissariat were infested by these cysts, or 42·6 per cent. The *post-mortem* examinations of cattle made in all parts of the Panjab revealed cysts most commonly of the hydatid or echinococcus kind.

These are the general results of the investigation made in the Panjab. The facts ascertained regarding each division of the province will now be stated briefly in chronological order.

Delhi Division—(*Districts—Delhi, Gurgaon, and Karnaul*).

Information regarding the districts of this Division is meagre; the town of Delhi was visited twice in July 1870, and a local investigation made on each occasion. The result was that a sporadic case of rinderpest was found in the city. The disease is here called *rorah*. 1870.

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The Deputy Commissioner of Gurgaon reported on the 12th of December 1870 that a disease had broken out in that district characterised by "looseness of the bowels, running from the mouth, and, after a day or two, violent purging; entire refusal to eat; death ensuing within a week." This is evidently rinderpest. Evidence of a more explicit kind was obtained on occasion of a visit to the Karnaul Stud in September 1870. *Man* rinderpest and *rorah* (foot and mouth disease) had been lately prevailing in the town of Karnaul, and the former has been always known, occurring in a epizöotic form every third or fourth year. The officers in charge of the stud (Colonel Parrott and Veterinary Surgeon Kettlewell) had not had their attention drawn to the subject.

HISSAR DIVISION—(*Districts—Hissar, Rohtuck, and Sirsa*).

Very valuable information regarding cattle murrains was obtained on occasion of the visit of the Commission to the Hissar Stud Farm in July 1870. One witness in particular—Hansari, a Salutrí—gave most excellent evidence, showing that *sirak* (rinderpest), *goli* (quarter-ill), *phíprí* (pleuro-pneumonia), and *rorah* or *khura-phata* (foot and mouth disease) have always been known in that locality. He stated that his elder brother, who was also a cow doctor, knew of *sirak* in the year 1810, and that he himself had since 1830 seen it attack the cattle in and near Hissar every fourth or fifth year. It had not occurred there during the last three years.

1810. 1830.

1864. In April 1864, Mr. H. Dawson, V.S., reported on the epizöotic which had lately prevailed among the cattle at Hissar, and from the *post-mortem* appearances noted, it is probable that more than one kind of disease had occurred, namely, quarter-ill and pleuro-pneumonia. So thoroughly convinced was Mr. Dawson of the contagious nature of these murrains, that he recommended, in the event of their again appearing amongst the Hissar cattle, that the diseased animals should be at once destroyed, and the healthy cattle broken up into small herds and sent to fresh grazing ground, never being allowed to graze for any considerable time in one place.

1866. In 1866 Mr. Dawson was called upon to report on the cattle murrains which had been prevailing in Hissar. His report enters fully into symptoms and treatment, and it is evident that the disease of which he writes was quarter-ill, which he considers contagious.

1860 to 1869 The annexed return of deaths among cattle during the ten years 1860-69 (page 457) shows a great mortality among them. In a stock averaging 9,930 head, there is a yearly average loss of 1,439, or 14·49 per cent. *Sirak*, *phíprí*, *goli* and *khura-phata* are noted as causes of death of almost yearly occurrence.

No information was obtained regarding the other districts of the Division.

UMBALLA DIVISION—(*Districts—Umballa, Ludiana and Simla*).

It is stated in an official communication from the Deputy Commissioner of Ludiana that a form of cattle disease called *newabi*, whose alleged symptoms resemble those of rinderpest, prevailed in the district twelve

1851. or thirteen years previously. It is also stated that *munkhí* and *rorah* occur every two or three years.

1870. *Mokh* or *manun* appeared in this district in March 1870, in the Jagraon Tahsil. It became epidemic in that Tahsil, affecting 42 villages, and spread to the adjoining Tahsils of Ludiana and Samrala.

The disease carried off 1,851 head of cattle in the 'Jagraon Tahsil and 252 in the Samrala, and it was said to have been imported into the latter by diseased cattle brought from Hissar. The disease was said to be "fast disappearing" in May, but a limited outbreak apparently of foot and mouth disease, was reported from one village in September.

Cattle disease prevailed widely in the district of Umballa in the months of June to November 1870. Both rinderpest and foot and mouth disease are noted. The general result, as shown in the table printed at page 460, is that in 73 villages, in a stock of 30,867 head. 4.608 were attacked, or 13 per cent.; and 1,146 died or 3 per cent. of stock and 27 per cent. of attacked.

In October of this year, rinderpest (*bararog*) and foot and mouth disease (*laru*) were reported to exist in the villages of Kotkhall and Kultína, in the Rajah of Keonthal's territory, in the Simla District Segregation appears to have been successfully carried out. No other localities in the district have been known to be attacked.

JULLUNDUR DIVISION—(*Districts—Jullundur, Hushiarpur, and Kandangra.*)

In June 1870 foot and mouth disease occurred among the Commissariat slaughter cattle at Dharmsala. The disease appears to have been imported from Jullundur. In this district both *megh*, rinderpest, and foot and mouth disease appear to have prevailed generally throughout the district during the years 1869 and 1870, though the number of deaths reported, 50 and 87, is small as compared with other districts. The Deputy Commissioner of Kangra reported in August 1870 that cattle plague existed to a large extent in his district. Captain Harcourt reported that *kurag-murag* (foot and mouth disease) prevailed extensively in the Kulu and Plach Tahsils of this district; 250 cattle had died in the former and 62 in the latter. It is open to question whether the disease which caused such a large mortality was foot and mouth disease only; but this form is distinctly named and described, and in the absence of exact data or of a professional inquiry, it is useless to speculate. 1869. 1870.

AMRITSAR DIVISION—(*Districts—Amritsar, Gurdaspur, and Sialkot.*)

The information obtained from this Division is full and interesting. The inhabitants of the village Vadala, six miles from Amritsar, which was visited by the Commission in August 1870, stated that *manun* (rinderpest) and *paira*, foot and mouth disease, have been known for many years in that district. A farmer of that village asserted that the disease *manun* had appeared in his village years ago, also in his father's and grandfather's time. Another man, aged 60, said that he first saw the disease when he was ten years old—1820, again when he was 1820.
30 years—1840, and again ten years ago—1860. Rinderpest prevailed 1840. 1860.
in village Chobala of Anjala Tahsil, Amritsar District, in May 1870, and continued to prevail till July. Fortnightly returns were received from 1870.
this district from 1st September to 15th December 1870, showing 155 deaths in 218 attacked—71·1 per cent. The symptoms described by the Deputy Commissioner are those of rinderpest. In Gurdaspur also disease prevailed widely during the year. Fortnightly reports from 1st September to 30th November show 1,107 deaths out of 4,102 attacked—26·98 per cent. A variety of diseases are given, but rinderpest and foot and mouth disease are prominent among them.

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As early as March 1870, murrain broke out in the Daska Tahsil of the Sialkot District, at a place about half-way between Sialkot and Gujranwala, on the high road: 2,327 cattle are reported to have died during the months March to July. It was believed that the disease was brought from the Gujranwala District. From the symptoms of the disease, as described by Sub-Assistant Surgeon Futteh Singh, it appears that both rinderpest (*manun*) and foot and mouth disease (*mokhar*) prevailed simultaneously. Fortnightly returns from 16th August to 30th November 1870 give a mortality of 3,112 among 3,914 attacked, or 79·5 per cent.

These returns were collected by Sub-Assistant Surgeon Futteh Singh who made a careful investigation into the circumstances of this murrain.

LAHORE DIVISION—(*Districts—Lahore, Gujranwala, and Ferozepur*).

1805. The district of Gujranwala in this Division holds a prominent position in the annals of cattle murrain in the Panjab. As early as the first decade of this century, there is oral evidence of the prevalence of *andar-ka-matah*, rinderpest. An inhabitant of Shekhupura, 80 years of age, testified to the Commission that he had seen the disease before his beard began to grow. In this place the Commission found both rinderpest and pleuro-pneumonia existing, as also in Kokoa, a village adjoining. A chowdry of *goallas* in the city of Lahore testified that *manun* (rinderpest) was known to his forefathers, and frequently appeared.

He had himself seen eight or nine outbreaks in a lifetime of 35 years.
1861. He had lost 11 cattle of it in 1861. Similar evidence was recorded
1869. regarding *phipri* or pleuro-pneumonia. In the hot weather of 1869 a most virulent murrain broke out on the bar of Gujranwala. This bar is a vast grazing ground where cattle are herded and collected on *rukhs* or pasture farms. This system of herding is purely nomadic, the herds being driven about in search of water; and where this precious element exists, a temporary village of huts is rapidly thrown up. In seasons of drought both pasture and water are bad, and the cattle are liable to a disease called *bhukni*, whose symptoms are incessant purging, wasting, and death. It was this disease which during the year ending March 1870, killed 40,525 cattle, valued at R9,51,298. Cases of it were studied by Dr. Quinnell, Civil Surgeon of Gujranwala, who noted excessive purging and emaciation as the prominent symptoms. Swelling of the dewlap and voracious appetite were observed in some cases. The disease was not supposed to be infectious, but to depend on local influences, and the *post-mortem* appearances indicated anæmia, mal-assimilation and mal-nutrition. The evidence recorded by the Commission was to the same effect. *Bhukni* and *pir* (rinderpest) were carefully distinguished by the people and the differential symptoms given. The people were not so familiar with the former as with the latter. They asserted that *bhukni* was not known until 1869; had begun in the Sarwal district, and spread thence into Gujranwala and Jhang, and in some cases the somewhat similar symptoms of *bhukni* and rinderpest were mixed up. Rinderpest is said to have prevailed in
1870. Lahore in 1869. In March 1870 murrain was reported to have again broken out on the Gujranwala bar, but the disease seems to have died out in May. Rinderpest and pleuro-pneumonia were, however, found prevailing in August 1870, and evidence was obtained of the existence of the former in the month of April in Lahore. Another outbreak of murrain was reported from the Kamoki Pargana of Gujranwala in September. It is supposed to have been pleuro-pneumonia, and it is stated that 100

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head of cattle had died within 24 days in two villages named Ghoga and Ude, a few miles on either side of the Gujranwala and Shekhupura Road. In another report received in September *bhukní* (diarrhœa) was said to be spreading from the bar upwards in the Nowshera Pargana, and it was added that in Hafizabad and on the bar pleuro-pneumonia was still causing loss. Cattle disease appeared in May in three pergunnahs of the Ferozepur District, and in two months 4,664 cattle are reported to have died. From the symptoms described by the Civil Surgeon, the disease appears to have been rinderpest.

MULTAN DIVISION—(*Districts—Multan, Jhang, Gugaira, and Musafferghar*).

The history of murrain in this Division repeats that of the last almost exactly: rinderpest from time immemorial, a well-known and frequently-prevalent disease; *bhukní* severely raging in 1869 on the bar, and both rinderpest, pleuro-pneumonia, and black quarter (*suth*) prevailing in 1870. Many oral records of past outbreaks during the spent portion of this century were noted by the Commission in conversations with the people in these villages, particularly the years 1820, 1830, 1840, and 1862; and rinderpest was seen both in the districts of Montgomery and Jhang, and its identity verified by *post-mortem* examination. The mortality from *bhukní* had been great. In the Chinote Tahsil 14,795 head of cattle were lost in 1869, valued at R3,51,215. This disease was generally said not to have occurred before the year 1867, but this is doubtful. Detailed evidence regarding diseases of cattle was recorded in both the Jhang and Montgomery Districts, and much accurate and interesting information regarding the five common forms—rinderpest, foot and mouth disease, *bhukní*, pleuro-pneumonia, and black quarter—will be found in the sequel.

RAWULPINDI DIVISION—(*Districts—Rawulpindi, Jhílum, Guserat, and Shahpur*).

Information from this Division is scanty. A report received from Murree in August 1870 shows that rinderpest and foot and mouth disease are known in the district, but no facts regarding prevalence are given. In Rawulpindi rinderpest broke out among the Commissariat cattle in December. The symptoms and *post-mortem* appearances were carefully studied by Veterinary Surgeon Moir.

No information has been obtained from the *Derajat* and *Peshawur Divisions*; but in the face of the evidence above summarised, it cannot be concluded that murrain is absent from these parts.

Cattle disease was also said to have prevailed in Usufzai in 1869, but no details were obtained from the Panjab Government.

MADRAS PRESIDENCY.

MADRAS PRESIDENCY.

The history of cattle murrain in the Madras Presidency is peculiarly interesting, because of the early notices which exist regarding cattle plagues; because in recent times the Madras Government took the initiative in investigating the subject, and stimulated an interest in the matter which has borne abundant fruits in other parts of India; because

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here a skilled agency was first employed to inquire into the subject and devise measures for the prevention and treatment of disease causing mortality among cattle; because a legislative enactment was devised for these purposes; and because, after three years' experience and continued attention to the subject by professional men and district officers, the application of the enactment so devised was authoritatively declared to be neither "expedient nor necessary," and the stamping out, limitation, and treatment of murrains were entrusted to the knowledge, the personal efforts, and influence of individuals.

These several points will be more fully brought out in the following remarks, which have designedly been made as brief as is consistent with clearness.

1791-92. In 1791-92, severe murrain broke out among the cattle with the Army of Lord Cornwallis at Bunjator and Seringapatam. This fact is mentioned in a report by Dr. J. MacRae, dated 11th November 1868, appended to Dr. C. Macnamara's work on Cholera.

1811. In 1811 cattle disease prevailed among the cattle of the depôt at Hunsur. It appears from the printed records (Selections from the Records of the Government of India, Home Department, No. 69) that murrain was very destructive in Mysore in that year. In order to prevent the infection of the reserve cattle, these were parcelled out into small portions, separated and distributed over the neighbouring pastures, while cattle returning from command were kept in quarantine. These measures, no doubt, saved a great number of the Government stock. Colonel John Hill, Commissary General, in reporting on the subject generally, states that "every means should be used to prevent the spread of the disease; *healthy cattle should, if possible, be moved from the neighbourhood of infected localities:* this proved particularly successful in Mysore, when the Amrut Mehal was in existence; and in seasons of sickness, when the casualties among private cattle which were not moved were counted by thousands, the Government herds very frequently escaped unscathed." The words italicised contain the principle of all that has been attempted in Madras for the prevention and limitation of cattle murrain, with what success will appear in the sequel. The nature of the disease is very manifest from the following terse description by Captain Harvey, Assistant Commissary General: "a purulent discharge from the nostrils, eyes, mouth, and ears, excoriating and ulcerating the parts, and a violent diarrhoea." Lieutenant M. Curbon calls it a "violent dysentery." The disease was no doubt rinderpest. While the cattle in the depôt remained comparatively healthy, detachments for Bellary, Chitaldurg, Nandidurg and Rayacottah, passing through affected places, were so severely seized that some of them were unable to proceed. This disease is called *bara asar*, or the great disease. Captain Harvey considers it to be the same as the "malignant epidemic fever which has so frequently ravaged the herds of the Continent of Europe." Stimulants, nutrition, and local disinfectants and astringents seem to have been the chief means of cure employed, and heavy fall of rain appears to have put a stop to the disease.

1848. In the year 1848 Dr. William Gilchrist published his "Practical Treatise" on the diseases of cattle, elephants, and camels. This excellent work was founded on personal observation and study at the Hunsur Cattle Farm, and has been, up to this time, a standard work of reference with Commissariat and Ordnance Officers, and others in charge of public stock. Murrain and foot and mouth disease hold a very prominent place in the category of cattle diseases, and the former is also described as one of the diseases to which camels are liable. Dr. Gilchrist's

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description of these diseases is reprinted below, and it is evident that the affection which he describes under the term 'murrain' is none other than that which has been so prominent in the preceding pages, and regarding which latter experience has taught the same conclusion as was arrived at by Dr. Gilchrist, namely, that it is identical with the murrain of Europe.

1852.

The next notice of murrain is also from the training depôt at Hunsur. The disease is said to be the same as that described by Captain Harvey in 1811, and the same treatment, namely, frequent injections of a solution of sugar of lead into the nose and ears, applying alum water to ulcerated parts, and the use of camphorated oil, was employed "with the best results."

1863.

In July 1863 Captain T. Nelson writes to the Collector of Karnul, describing a murrain which had prevailed in that district during the preceding three months, and had carried off hundreds of cattle. He states that this murrain reduced herds by half, and describes as the symptoms,—refusal of food, ears drooping, eyes watering, purging, succeeded by a bloody flux, an eruption of large pustules covering the whole body, and death between the fifth and tenth days. He proposes *inoculation* as a protective measure. This letter is forwarded by Mr. J. Minchin, Collector of Karnul, to the Board of Revenue, with a remark that "the disease is the cause of enormous losses to the agriculturists throughout the Presidency, and recommends the institution of experiments to test the value of inoculation. The Board of Revenue transmit the papers to Government, the Inspector General of Hospitals, and the Commissary General, and note "the serious diminution of stock which was brought to light by the last quinquennial returns." They "feel that the matter is not ripe for action," and suggest *Local Committees* of Medical, Commissariat, and Revenue Officers to collect and digest facts and consider and propose remedies.

This latter important proposal has not been so frequently adopted as it ought; but the advantages of the measures are very apparent from the excellent results of the Benares Committee in 1869 (see Appendix, p. 348) which threw such light on the nature and origin of the disease raging in that station and district.

The Madras Government request the Commissary General to report whether similar disease has ever appeared at Hunsur. The result is given above. They also move the other Governments in India to inquire into the matter and consult the Medical Department as to inoculation, which, they consider, should be made the subject of experiment.

Later in the year (November) Assistant Surgeon G. Bidie, M.D., informs the Deputy Commissary General that the disease described by Captain Nelson is the *doddah rogah* or *bara asar*, "well known in Western-Mysore—very fatal—destroying nearly all the stock in a village." He also states that the natives on its appearance adopt means of segregation, keeping their cattle away from attacked villages. He says that the causes are quite unknown, that the murrain is most virulent in the hot weather, and that fatigue, insufficient food or water, and whatever reduces the vital powers, predispose to an attack. The symptoms described are those characteristic of rinderpest; he notes that the body may, in advanced stages, become covered with pustules, and consider the murrain more like plague than small-pox.

The treatment he recommends is,—slight laxatives in early stages, and salines, cordials, and sedative astringents as the disease advances. He regards inoculation as dangerous, tending to increase rather than diminish the ravages of the disease.

OXEN.	Selections from Report of Indian Cattle

MADRAS PRESIDENCY

Historical Sketch.

1864.

The Government now appoint Veterinary Surgeon J Thacker to investigate and report upon the disease, and Mr Thacker contributes a valuable series of reports upon the nature and prevalence of murrain in this Presidency, and the measures adopted to check it, upon which the following remarks are founded Mr Thacker in the first instance visited the Karnul District, and from January to April was employed in investigating the disease there, and applying remedies and measures to cure the sick and prevent the spread of the disease. His report, which appears to have been written in May, is full and interesting The following are in short the main facts and considerations contained in it.—Mr Thacker found the murrain at Budacherla and Ravipad in the Karnul District, where he had abundant opportunities of studying it The disease was called *pedda musa rogum* Mr Thacker was confirmed in his opinion of its identity with the murrain of Europe. His description leaves no doubt on that point He notes that he did not find the exanthematous or eruptive form of the murrain prevailing, and that this variety occurred during or after the rainy season He found that without personal support from the civil authorities he could do little in the way of inducing the people to submit to any rules for treatment or prevention He saved 33 out of 44 cases treated at Ravipad (75 per cent) He prescribed the simple bazar drugs easily procurable by the people,—camphor, nitre, opium, catechu, and datura, and places great stress on the continuous administration of nourishing gruel. He can assign no cause for the disease, but considers it infectious, this is acknowledged by the natives, but they take no means whatever to separate sick and healthy He recommends cleanliness, disinfection, segregation, isolation of sick, and treatment. As to inoculation, he considers that it would only propagate a dangerous disease He finally recommends the employment of a qualified officer to interest the ryots in treating the malady, and see that necessary measures are carried out

The Collector of Karnul, in forwarding the report to the Board of Revenue, is sanguine as to the success of medical treatment, and states that he intends translating, printing and circulating widely Mr Thacker's directions for treatment, etc He thinks that nothing short of a special legal enactment will ensure the application of preventive and sanitary measures in which he places his chief trust. He proposes an Act providing for the erection of hospital sheds, the cure of the sick, early report of disease under penalty and disinfection of infected premises. He would have breaches of the Act made punishable under Sections 269 and 270, Indian Penal Code, and the Act made, not compulsory, but capable of application on the requisition of the local authorities. He estimates the yearly loss of cattle in the Kurnool District from murrain at 2,000. He supports the proposal to employ a qualified man for the special duty of repressing and treating cattle disease, and would place a staff of pupils under him to acquire veterinary knowledge.

The Board, in forwarding the above to Government, concur in the opinion as to the necessity of legislative action.

In June 1864 Mr W G Maclvor, Superintendent of the Government Cinchona Plantations, sends a careful report of murrain which raged in the Nilgherry Hills to the Collector of Coimbatore. This report leaves no doubt that this murrain was a severe form of rinderpest,—an opinion recorded by Mr Thacker in a letter dated 12th July 1864. The Madras Government, in considering these papers, receive the proposal to legislate favourably and ask the Board to submit a draft, approve of Mr. Thacker's special employment, and wish to have inoculation tested.

In June of this year Dr. Shortt described a disease of sheep, in which

swelling under the jaw was the most prominent early symptom; and if the animals recovered from this, purging supervened on the fifth day, and death was the invariable result. He found no "flukes" in the animals examined; he attributed the disease to diet, and found that the only animals which escaped were fed on grain food. He recommends change of diet and salt, and considers the disease infectious. He also notes the prevalence of *komari*, or epizootic aphtha, among the cattle in the district (Coimbatore).

Mr. Maclvor reports further in July 1864 that rinderpest broke out on the hill in August 1863, and proved most virulent, not more than 2 per cent. recovering. He shows by personal experience *the superior efficacy of removing the healthy to removing the sick as a sanitary measure.* In this opinion Mr. Thacker concurs, pointing out at the same time the greater trouble and inconvenience of the former proceeding. The next notice of murrain is also from the hills. Mr. J. Anderson, Assistant Apothecary, Lawrence Asylum Works, Loredah, gives a most interesting account of an outbreak of rinderpest which took place in the months of July and August. The disease was imported from the plains by cattle which had been sent down to Coimbatore to fetch machinery. One of *these* was attacked eight days after their return, and thirteen others of the same lot were subsequently seized. Of the first five animals attacked, four died and only one recovered. Mr. Thacker's published directions for treatment were then adopted, and of thirteen attacked, four were saved in the early stage by the administration of slight laxatives and gruel, and eight were saved after diarrhœa had set in by giving camphor, datura, nitre, chiretta, and arrack in *suji* gruel; only one old, debilitated animal died. Mr. Thacker, in forwarding this report to the Collector of Coimbatore, states that the native cattle owners, on the outbreak of this disease, "immediately drove away their cattle many miles distant." 1865.

The Collector of Coimbatore forwards these papers to the Board of Revenue, and remarks that a good many cattle had died on the hills from the effects of sore-throat.

Cattle disease (rinderpest) is next reported from Madamalai and Munsicoil in the Sigur Valley among the cattle belonging to the Forest Department. The disease broke out on the 24th December 1865, and out of 150 bullocks, 31 were attacked, 12 died, and 19 recovered. The treatment pursued was similar to that adopted by Mr. Thacker,—chlorate of potash and gruel being given in the early stages, and opium and gruel in the later. 1866.

Mr. Thacker's next report is dated 2nd March 1866. He obtained personal experience of the disease in January at Ootacamund, and was confirmed in his opinion that it was the true rinderpest of Europe. He found also that the herds on the Nilgherry Hills had been periodically attacked with it, but that no definite information was to be obtained. The oral testimony of the inhabitants was to the effect that the disease was not known on the hills until Ootacamund became a European settlement. He ascertained that the Todas and Badaghars (hill tribes) established a vigorous quarantine on its appearance, and broke up their herds into detachments. They considered medical treatment of no avail, and declined it. He next details the causes, symptoms, and pathological appearances of the disease at length. These accord closely with the observations of this Commission. He gives a striking illustration of the contagiousness of the disease; under treatment, he cannot advise vaccination for want of experimental proof of its value. He inoculated three animals with rinderpest, two of which died, and while desiderating further trials, adheres to his previously recorded opinion as to the danger of disseminating the disease

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Historical Sketch.

by this proceeding. He considers segregation an established rule, and prescribes the treatment previously advised. In conclusion, he advocates the employment of a special agency and legislation on occasions of outbreaks; the breaking up of herds into detachments; scrupulous segregation; cleanliness; *disuse of cowdung*; and burial with hides on.

In May of this year Dr. Shortt submitted another report on cattle disease which prevailed in Mangalore and Yercand on the Shevaroy Hills in April 1866.

He found that the disease was called *ummay* or small-pox, and describes most accurately the symptoms and *post-mortem* appearances of rinderpest from a careful examination of living and dead animals. He notes the ulcerated condition of the mucous membrane of the mouth and the congestion of the skin, and subcutaneous tissue causing a rough feeling of the skin. Dr. Shortt concludes that the disease so carefully observed by him is rinderpest. He found the mortality in two herds of 80 and 103 head of cattle to be 27·5 and 32·03 per cent. He noted the spread of the disease by means of common pasture grounds, and that a smart shower of rain seemed to put a stop to it. He also describes in Yercand another most important disease of cattle causing death, namely, hydatid cysts in the livers and lungs, causing emaciation, debility, and death. He attributes this condition to a bad system of feeding, and notes the case of one coffee plantation on which the cattle fed on the leaves of lime, orange, and pomelo trees, and were free of entozoa. Mr. Thacker's next report is dated 18th September 1866; he describes an outbreak of *tondinow* or malignant sore-throat in some villages of the Nilgherry Hills in May, and attributes it to cattle feeding on swampy pasture, owing to the unusual drought succeeding the early rain. The same disease, we are informed in a subsequent report, called also *domma pegulu* (Telugu), broke out in the Karnul District in December 1866. Mr. Thacker gives a careful description of it, and advises separation and change of pasture. He places little reliance on medical treatment. In December also, he describes a severe outbreak of foot and mouth disease (*kala jarah* and *bayi jarah*) at Kendal, near Ootacamund which forms an exact parallel to the experience of the Commission at Darjeeling. The mortality was very great (14 per cent.), owing to the owners of cattle employing sick animals for work, because of the scarcity in the number of these required for draught purposes. He next gives particulars of an outbreak of rinderpest in Bellary and Karnul in May and June. He obtained 48·27 per cent. of recoveries against 33·3 before his arrival. The healthy cattle were picketed out in detachments 200 yards distant from each other, a quarter of a mile away from the sick, and the effect was to "modify the type, and eventually exterminate the disease." Reports of cattle disease were received from South Arcot (rinderpest) and North Arcot (*nulli*—nature unknown).

This year is signalized by the passing of an Act (II of 1866) in the Madras Council for the prevention of the spread of cattle disease in the Madras Presidency. The application of the provisions of this Act is placed in the power of the Governor in Council. It provides for the establishment of *hospital pounds* under direction of the Magistrate of the District; inculcates, under penalty, the duty of the owner to report to the pound-keeper attack by contagious disease; directs the pound-keeper to examine the animal, order its removal to the hospital pound, and the disinfection of the shed in which it was kept; gives this official power to examine and inspect suspected animals and contaminated premises, and act as circumstances demand; provides that the expense of food and treatment may be defrayed by the Pound Fund or owner;

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Historical Sketch.

gives the pound-keeper power to destroy diseased animals when advisable; directs burial, and does not admit compensation; renders the levy of fees for care and treatment lawful, and sale of the animal to realise them; prohibits the removal of diseased or suspected animals without a license from the pound-keeper; attaches a penalty to disobedience of the pound-keeper's orders, or opposing the seizure of cattle under the Act; provides a remedy for illegal or improper seizure; places fees and fines to the credit of the Cattle Pound Fund; and gives the Governor in Council power to enact bye-laws more effectually to prevent the spread of disease.

1867. Mr. Thacker next reports (26th March 1867) on an outbreak of *vekkai* (rinderpest) in the North Arcot District, which commenced 12th December 1866. He resorted to the system of picketing healthy cattle out in detachments, and found the villagers willing to adopt this measure. To this system he attaches great importance, and suggests that the Cattle Plague Act should not be applied to the district. He continues the same method of treatment, and records a most striking fact with regard to the advantage of careful dieting. "I find that the cattle of the six prior villages have died to a larger extent, as of 300 attacked, 250 died and 50 only recovered; whereas in the village of Pallaveram, of 128 attacked, 65 recovered. Such a striking contrast I find to have arisen from the care and attention of the latter village people, having saved them by daily administering quantities of gruel."

In April Mr. Thacker found that the measure of segregation adopted at Pallaveram had "resulted in the extinction of the disease." He found the disease prevailing in other villages of the North Arcot District, and put in practice the same methods of sanitary and medical treatment, of whose success he writes in a very sanguine manner.

The next report is dated 12th September 1867. Mr. Thacker was informed of the existence of rinderpest in Conjeveram, Madras District, but failed to see the disease, which had subsided before his arrival. Cattle disease was reported from Trichinopoli (fever of a typhoid kind), from Bellary, and from Coimbatore. He visited Coonoor, and found that cattle were dying from an impoverished condition, probably caused by a deficiency of salt, and ameliorated by an increased supply of it. He found rinderpest (*vekkai*) prevailing at Pulloor, in the Madras District, and again put in practice, with success, the methods of segregation and treatment above described. The District of Cuddapah was next visited, where many deaths had occurred from *saraku*, apparently a kind of rinderpest, and the usual plan of treatment advised. *Vekkai* (rinderpest) was found in another village of North Arcot; and at Kongiem, in the Coimbatore District, cattle and sheep were found suffering from an enzöotic fever, owing to local and climatic causes, called *alari-novu*. Another disease, *gunda-musara*, was reported from Cuddapah, but its nature does not appear. From Nellore the prevalence of seven different species of cattle disease was reported, among which Mr. Thacker was able to identify rinderpest, foot and mouth disease, and malignant sore-throat, and advised accordingly. Mr. Thacker's attention was next drawn to an epizöotic among Government camels at Bangalore, which turned out to be caused by hydatids. He was next called to Coimbatore, where he found rinderpest (*kudinow* or *pytchinow*) raging in several villages, Kaity, Malleada, Kandal, etc. He found that the cattle of Kaity had caught the disease from an infected pasture, and gives an instance of a herd of 40 escaping the murrain by being separated and isolated. He recommends the continued employment of a Veterinary Surgeon, and remarks on the various types which the disease is apt to assume from variations of

climate. In a letter to the Collector of Coimbatore, Mr. Thacker details measures by which rinderpest was stamped out among a herd of 50 buffaloes, by their being placed in isolated kraals. The Board of Revenue and Madras Government accept these reports as satisfactory, approve of his continued employment, and request him to prepare a simple manual on the subject of cattle diseases in the Presidency, and their treatment.

1868. Mr. Thacker's next report is dated 9th September 1868. He gives a narrative of the reports of cattle disease submitted to him, and his personal experience in localities visited by him; but as the paper is curiously void of dates, it is difficult to know when the outbreaks described occurred. He finds very virulent rinderpest on the Nilgherries, and once again confirms the propriety of segregating. At Kotergherry and Coonoor segregation and treatment were again adopted with apparent success. At Hunsur an outbreak of *bara asar* was reported, but ceased before Mr. Thacker arrived. He then visited North Arcot, and found rinderpest (*vekkai*) prevailing there. A most instructive instance is noted of disease having broken out afresh, in consequence of measures for isolation having been relaxed. Rinderpest was also reported from the Cuddapah District. Coimbatore was again visited, and rinderpest found prevailing. His attention was next drawn to the Madras District, where segregation and treatment were again adopted with apparent success. Disease continued to be reported from Salem, Coimbatore, North and South Arcot, and Cuddapah Districts, and an outbreak of foot and mouth disease occurred at Bangalore without any casualties.

In addition, reports of rinderpest were received from South Canara, Secundrabad, and Bellary, and of foot and mouth disease from the Salem District; from the Kistna and Karnul Districts reports were received and medicines and instructions supplied. Mr. Thacker, in conclusion, insists upon the benefits of segregation, stating that, when carried out according to his instructions, he has never seen it fail. He defines the system as consisting in separating the healthy cattle into detachments picketed at 300 yards from the village and 200 yards distant from each other, treating the sick in the village and continuing the segregation for 15 days after cessation of disease. He states that the people have confidence in his medicine, and promises a manual.

Mr. Thacker's next report is dated 27th April 1869. In September 1868, he proceeded to Malabar, but found that cattle disease had ceased there. Disease was again reported from North Arcot and Karnul. Rinderpest prevailed in October and November around the Sheveroy Hills and on the Nilgherries; at Yercand cases of black quarter, called *chuppaniovu* or *thalorinovu*, (Tamil) occurred. In December rinderpest prevailed in the Salem District, and outbreaks were then traced to animals purchased at markets. Reports were meantime received from Karnul, Malabar, North Arcot, South Canara, and the Nilgherries.

1869. In January Mr. Thacker visited the Kistna District, where he found rinderpest, but experienced some difficulty in getting his plan of segregation carried out. On his return to Madras he received reports of cattle disease from Karnul, Coimbatore, and South Canara, and saw rinderpest in North Arcot and Coimbatore, in which latter place he found that his instructions had been carried out with gratifying success. Appended to this paper is a report from the Head Assistant Collector, Kistna District, showing the difficulties and advantages of Mr. Thacker's plan of segregation, and recommending the Act to be amended accordingly, but that the system, for success, should be carried out under efficient supervision. As to the advisability of applying the Act, the Collector of North Arcot earn-

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Historical Sketch.

estly deprecates the measure; the Collector of Coimbatore does not consider the introduction of the Act necessary, and considers that the people are ready to carry out measures for segregation and treatment; the Board of Revenue "recommend Government to continue the measures now in operation with so much success, in preference to appealing to the Legislature," and Government decide (24th June 1869) that the introduction of the Cattle Disease Act, or any similar enactment, is not called for at present.

Mr. Thacker's next report is dated 1st October 1869. Cattle disease was reported from Karnul, Salem, Bellary, Nellore, North and South Arcot, South Canara, Malabar, and the Nilgherry Hills. Medicine was liberally supplied and segregation practised—in some instances with signal success. It is somewhat difficult from Mr. Thacker's, in many cases, giving local names of villages and taluks without indicating the district, and giving the vernacular name of the disease without explaining the symptoms or English synonym, to give a very clear summary of the information contained in this report; but it is manifest that attention was generally directed to cattle diseases throughout the Presidency; that much rinderpest prevailed all over it, and that measures of treatment and segregation were applied with energy and gratifying result.

As an illustration of its appreciation by the people, the Board quote the instance of a herd of buffaloes which was attacked with murrain near Kotagherry, where Mr. Thacker found that the people who had formerly been instructed in the system of segregation "had already adopted it; the healthy cattle had been removed, and the disease soon ceased." Disease also prevailed in Mysore during the official year 1869-70. The mortality is put down at 23,907 head, and the loss, at R20 per head, R4,78,140. The murrain is called *dod rogue*, and prevailed throughout the Hassan District of the Ashtagram Division. The symptoms of rinderpest are correctly given, and foot and mouth disease is also said to be very common. The next report from Mr. Thacker is dated 31st March 1870. Up to the end of 1869 his attention was principally drawn to Karnul, Malabar, and Kandal on the Nilgherries.

In January 1870 murrain continued to rage in Malabar, South Kanara, and Karnul.

The District of Nellore was visited and cattle treated with favourable results; but the people were averse to carrying out segregation as strictly as they were instructed, and the disease consequently lingered on. In another part of the district, however, they had voluntarily adopted the system, together with burial of carcasses without removing the hides, and this was followed by "marked success" in staying the progress of the disease. Subsequently murrain was reported from Karnul, South Canara, North Arcot, Salem, and Bellary, and treated on the same principles. Government note, in commenting on this report, that the treatment employed has been generally successful, and the people are beginning to see the wholesome results of segregation. 1870.

A later report, dated 14th November 1870, for the half-year ending 30th September, details the prevalence of cattle disease in Malabar, Canara, the Nilgherries, Cuddapah, Bellary, Karnul, Madura, Secundrabad, and Salem. The same principles of segregation, parcelling out herds, and treatment were adopted, and in all instances, when the plan was carefully carried out, with success. Mr. Thacker writes: "Segregation has been, whenever adopted, invariably successful in stopping outbreaks of disease. It is a preventive measure of incalculable value to the country. It would save the lives of thousands of cattle, and I exceedingly regret that, under present circumstances, it cannot at all times be carried out.

OXEN.	Selections from Report of Indian Cattle

MADRAS PRESIDENCY.

Historical Sketch.

The general inferences to be drawn from the experience in Madras are—

1. That rinderpest, known most commonly by the names *vekkai, ummai, bara asar, doddah rogue, kudinow, saraku,* etc., is a well-known and widespread disease in the Presidency, and has prevailed extensively since inquiries began to be made into the subject.

2. That foot and mouth disease, swelled throat, black quarter, and cystic disease are also common forms of cattle sickness.

3. That for the prevention and treatment of rinderpest strict segregation and medical treatment have been found successful.

4. That the separating of the healthy is better than removing the sick.

5. That by carefully conducted segregative methods the disease may be effectually limited to a certain locality or number of cattle, and its further spread prevented.

6. That by suitable dieting and careful medical treatment a certain number of animals recover more than if they were left to nature.

7. That any legislative interference is considered strongly unadvisable in the Presidency, after careful and anxious attention has been bestowed upon the subject.

8. That by persuasion, example, and personal influence the people may be brought to adopt the necessary measures of prevention and treatment.

9. That the plan of protecting cattle by inoculation has not been entertained favourably, and all the thought and action adopted has tended to the opposite aim, namely, repression or stamping out.

The following are the forms (Nos. 1 and 4) which have been used to elicit written information of a more general or detailed description :—

FORM No. 1.

Questions.

1. Name of District, Taluk or Mouzah and Village?
2. Name of Disease in Vernacular or English?
3. Date of outbreak of disease?
4. Number of cattle attacked?
5. Number of cattle which have died?
6. Number of cattle which have recovered?
7. Number of cattle still ill?
8. Number of cattle belonging to the village?
9. Whether the disease is supposed to be infectious or not?
10. How supposed to have originated?
11. Symptoms of the disease?
12. Average duration of attack before recovery or death?
13. As to whether any preventive or remedial measures have been used or not, and with any success or not?

FORM No. 4.

Questions.

1. Name of locality?
   Area in bigahs, acres or miles?
   Geography and nature of soil?

Plague Commission, 1871. (*H. T. Pease.*)	OXEN.
	Form No. 4.

2. Number of cattle in the locality, and number to square mile ?
3. Different breeds of cattle in the locality ?
   Average value of cattle per head ?
   Now and 10 years ago ?
4. Uses for which cattle are employed ?
   I.—Agriculture, how and when ?
      Bullocks or cows employed ?
   II.—Draught and burden ?
      Treatment of cattle so employed ?
   III.—Dairy ?
      Proportion used for each purpose ?
5. Mode of housing ?
   Kind of cattle sheds when used ?
6. Mode of feeding and watering ?
   Particular kinds of grass and fodder ?
   Native names and specimens if possible ?
   Water whence obtained ?
7. Whether herded by day or night, or at any seasons ?
   Particulars requested ?
8. Whether cattle are herded and driven for pasture to other districts ?
   If so, whither and to what distance ?
9. General condition of cattle ?
10. Stock how kept up ?
    I.—By breeding ?
       Special bulls kept ?
    II.—By importation ?
       Whence ?
       Average price paid ?
11. Mode in which cattle are bought and sold ?
    Hâts, markets, etc. ?
12. Export of cattle, if any, whither, and for what purpose ?
13. Export of hides ?
    Number of dealers, whether increased of late or not ?
    Price of hides now and ten years ago ?
    How hide trade is conducted ?
14. Mortality among cattle, ordinary and from plague ?
15. History of plagues ?
    In what years they occurred ?
16. Character of plagues, source, cause, mode of spread, etc. ?
17. Season in which plagues prevail ?
18. Whether different varieties are apt to prevail at different seasons ?
    Duration of such outbreak ?
19. Statistics of cattle plague ?
    Proportion per cent. of attacked ?
    Proportion per cent. of recoveries ?
    Proportion per cent. of deaths ?
20. Kind of cattle most liable to attack with regard to
    Breeds,
    Age,
    Sex, and
    Condition ?
21. Symptoms ?
    Shivering ?
    Appetite and rumination ?
    Skin, temperature, hair, eruption, etc. ?

O. 551-594.

orm No. 4

Swelling of tongue and throat?
Difficulty in breathing, cough, etc.?
Looseness of bowels; blood or mucus?
Secretion of milk suppressed or altered?
Posture of animals?

22. If body examined after death, what appearances?
23. Opinion of reporter as to contagiousness of different varieties of cattle plague?
24. Treatment of cattle diseases?
    Effects of different methods?
25. Sanitary measures, if any, adopted?
    Disinfection?
    Separation of sick and healthy?
    Burial of carcasses?
26. Hides, horns and hoofs of diseased cattle how disposed of?
27. Prevalence of disease among other animals during cattle plague?
28. Affection of man by disease prevailing among cattle?
29. Disease at present prevailing?
    Particulars?
30. Effects of weather and heavy falls of rain?
31. Any other remarks on points not above mentioned?

THE ANDAMAN ISLANDS.

Historical Sketch.

The insular position of this Settlement, its comparatively recent occupancy (1858), and the accurate history which has been kept of all events which have transpired there since then, render the study of any cattle plagues which may have happened extremely interesting. The same remark applies to cholera, whose outbreaks in this island have been recorded by Dr. C Macnamara in his well-known treatise on Asiatic Cholera. It is very clear that cattle disease was not *indigenous* in the Andaman Islands, because there were no cattle there among which the disease could originate; and, as will appear from the sequel, disease did break out among cattle on more than one occasion, and then was stamped out by judicious repressive measures.

1864-65 The first annual report on the Settlement is for the year 1864-65. It is stated that all supplies and live-stock were obtained from Calcutta, and that cattle and sheep were kept at "Aberdeen" and Viper Island, where the best grazing was to be found. Guinea and *dub* grass were being planted to improve the pasture.

1865-66. Three hundred and twenty-seven head of cattle and 3,697 sheep were imported from Calcutta and British Burmah during the year. There was mortality among sheep twice in July in the height of the south-west monsoon, and in April in the height of the hot weather. The cause of mortality is not noted.

The planting of Guinea grass had proved a great success, but not so *dub* grass. The supply of fodder was noted sufficient, and the establishing of an experimental cattle farm contemplated.

1866-67. The cattle farm at Aberdeen was considerably extended during this year, and several new sheds constructed. A new farm was opened out at Perseverance Point. The cultivation of Guinea grass continued successful, but *dub* grass is not mentioned. All the slaughter cattle were

obtained from Burma It is noted that "the cattle have been generally healthy All our slaughter cattle are old, worn-out creatures, and never appear very fat The deaths which occur among them arise from old age, and are not it would seem, attributable to disease or the effects of the climate The sheep on the other hand do not thrive here At all times mortality among them is very heavy, and sometimes it increases to a very high rate The very hot and the very wet months are particularly baneful to them, added to this, the voyage from Calcutta has a most injurious effect on the animals, from which they do not recover for nearly two months after their arrival, during which interval numbers die off"

A cattle show was held for the first time this year, when it was noted that considerable progress was evident in breeding and feeding cows, goats and poultry

The cattle farm at Perseverance Point is noted as a success, and the cultivation of Guinea grass seems to have been extended. 1867 68.

The farm at Aberdeen was not so well reported on, specially as regards the sheep, and the low situation and damp are said to have caused large mortality among the latter No epizootic is noted during the official year

"In the month of September 1868" Dr Rean writes in his annual report, "cattle disease appeared among the Commissariat cattle and carried off many It had been introduced from Burma, and threatened to spread among the horned cattle here, had it done so, the loss would have been very great, and the advance of the Settlement towards becoming independent of foreign meat supplies much retarded Fortunately, by the exercise of much vigilance, the disease did not extend, and in future great care will be observed in preventing communication between newly-arrived cattle and those already here" Dr Rean has forwarded the report of the Committee which was appointed to investigate this matter, which is full and interesting 1868 69.

In his annual report for 1869, Dr. Rean remarks as follows with regard to the stock of the Settlement —

"*Cattle* —A good number of cows have been imported from Penang during the year, they are of smaller size and inferior to those from Burma or India, and contrast most unfavourably with the animals formerly imported, and now the property of numerous ticket-of-leave prisoners The magnificent pasturage which can be obtained here should enable us in a few years to rear as fine a class of cattle as can be met with in India, and with equal economy No cattle disease has broken out among the herds this year as happened last, and it is hoped by care in the importation of these animals, and watchfulness on their arrival here, we shall not have any murrain among them again

"*Sheep* —In former years the mortality among sheep on ship-board and after their arrival here was very great, but during the past year much improvement has taken place, more care has been exercised in selecting a finer class of animals and greater precautions taken on the voyage They are well housed on arrival, and the experience now gained in their management seems sufficient to secure an immunity from any great loss among them for the future.

* * * * * * * * * *

"*Pigs* —These animals thrive remarkably well and increase greatly."

In the Annual Administration Report for 1869-70 a census of stock on 1st April 1870 is given, namely, 858 cows, 264 male calves, 340 female calves, 2,240 goats, and 729 pigs; 129 cows were sent to the Nicobar Islands and were doing exceedingly well. It is noted that wild buffaloes exist in the latter—"the produce of some cattle left here by the Danish settlers." In April some cattle received from Calcutta introduced an epidemic of foot and mouth disease, from which three of the imported cattle were suffering. It will be observed that the existence of this disease 1870.

THE ANDAMANS.
Historical Sketch.

in and around Calcutta at that time was noted by the Commission (p. 11). It spread during the month and caused four deaths in old and weakly animals. Isolation was being adopted and remedies applied.

In the report for the month of May it is noted that nearly all the cattle on the Settlement were attacked, notwithstanding precautions. Sixty-seven casualties had occurred, which in a stock of about 1,400 gives 4 per cent.—a considerable loss.

In the report for June it is noted that the health of the cattle had improved, and that only some of the weaker had yielded to the disease; 20 deaths are noted.

The foregoing notes have been gleaned from the Administration Reports, and indicate the value which would attach to a more detailed history of the introduction of horned stock, and subsequently of disease, into these islands. It may fairly be concluded that the two forms of murrain observed in the Andamans—rinderpest and foot and mouth disease—were not of spontaneous origin there, while the great endemic diseases, fever, diarrhœa, and dysentery, are as rife in the Settlement as in other malarious localities. It is equally clear that these diseases were introduced by diseased stock; and if the same amount of care were taken in endeavouring to prevent their spread, it would appear that foot and mouth disease is more infectious and penetrating than the other, but details are wanting on this point. It is obvious that a quarantine farm, station, or island would save the stock of the Settlement from risk, and while disease is so rife on the continent of India, and its introduction so possible, nay probable, and a proved fact on two occasions, the increasing stock of the Andamans and Nicobars ought to be thus protected.

CEYLON.

Summary of the Report of the Ceylon Cattle Disease Commission.

Summary of Report of Cattle Disease Commission.

Though the Government of Ceylon is distinct from that of the continent which it adjoins, and events occurring there may be considered foreign to the concern of an Indian Commission, still the results of a very carefully conducted investigation into the cattle murrains prevailing there, by a Commission specially appointed for that purpose, are so interesting and important, that it has been thought best briefly to epitomise the excellent report which was drawn up on this subject, so as to bring the principal facts revealed and conclusions arrived at into relation with those contained in this report, in order that the whole subject may be presented in its utmost completeness, and every available light thrown upon the questions connected with it. The prevalence of murrain in this island was not unknown previous to the appearance of this report. An interesting paper on the subject is contained in *The Journal of the Agricultural and Horticultural Society, Volume I., page 235.* This paper, written by Mr. J. Lambert, refers to an epidemic prevailing in 1842, and it is evident that at that time murrain was very common in the island. The Ceylon Cattle Plague Commission consisted of a Civilian, a Medical man, a Veterinary Surgeon, and a Maha Mudliyar. Its constitution was therefore very similar to that of the Indian Cattle Plague Commission. Its labours commenced in April 1868, and the report is dated October 1869. Six journeys were made to different parts of the island, the conditions under which stock existed examined, their diseases studied, and the evidence of natives, planters, and officials recorded regarding these.

CEYLON.

Summary of Report of Cattle Disease Commission.

Written statements and mortuary returns were also called for and obtained. The inquiry was therefore practical and complete, and the information recorded is ample and intelligently placed in the general report. The Commission enter rather fully into questions connected with cultivation, care of stock, breeding, pasturage, housing, etc. As compared with Bengal, their descriptions exhibit a vastly inferior picture with regard to each of these particulars, and they show convincing cause for energy in the way of improving agriculture and stock. As regards *diseases* of stock, they found rinderpest and foot and mouth disease very common, and it is to the former that their chief attention was directed.

The *nature* of the disease they confidently assert to be "identical in its leading features with the rinderpest of Europe and India." They note the general absence of skin eruptions, but state that the Veterinary Member had observed this feature in previous years. They also comment on throat disease, which has been such a prominently observed and described malady in many of the reports printed above. They believe this to be a form of rinderpest, because in all the cases of it examined by them they found the other more peculiar and characteristic signs of rinderpest present. Distended stomach and staggers are also noted as prevalent forms of disease. It is curious to note the absence of black quarter, pleuro-pneumonia, and cyst disease, which have been so pointedly described on the continent of India.

As regards the *history* of murrains, the Commission could not trace out any early record, or fix on any period of origin; but it appeared from oral evidence that murrain existed during the Singalese period. They concluded also that up to 1840 its visitations were comparatively mild, but that since that year "disease made its appearance with greater frequency and violence and with more fatal results." This, they remark, may have been owing to the rapid extension of coffee planting and the more active importation movement, and more intimate association of cattle consequent thereon.

As regards *mortality*, they note that during the three years ended 1867 the average reported yearly loss was not less than 70,000 head, giving a money loss of £60,000. The stock of the island is not estimated, but taking it at one million, apparently an excessive extimate, the yearly loss would amount to 7 per cent. It is noted that "the value of a buffalo or bullock has in many localities been doubled within the last few years," and that cultivation is seriously impeded in numerous instances, owing to loss of cattle by disease. It also appears that coffee cultivation is in Ceylon depriving cattle of pasture land, as rice cultivation is in Lower Bengal. The effect of drought and bad grazing is prominently dwelt on as predisposing to murrain.

The *contagiousness* of both forms of murrain is accepted as an indisputable fact, and a principle upon which preventive measures must hinge. The various means and modes by which the disease may spread are also enumerated.

As regards *treatment*, preventive treatment is assigned the most prominent place. Isolation, segregation, and disinfection, are the main features of the plan proposed. The primary agent of this repressive system is the village head man, to whom, under penalty for neglect, immediate report is to be made; he is to take immediate steps on assuring himself of the necessity in the way of preliminary separation. The agent of the district is to be informed at once, and on him will rest the burden of future measures, provided the early steps have been imperfect or ineffectual.

OXEN. | **Selections from Report of Indian Cattle, etc.**

CEYLON.

Summary of Report of Cattle Disease Commission.

The hospital treatment recommended is an early dose of salt and sulphur, carbolic acid, water, "frequent feeds of thick rice congi" and counter-irritation in throat cases.

The advantage of giving discretion to local agents who know the circumstances of the district is indicated, and a legislative enactment is recommended, having for its objects—

1. Quarantine for new arrivals (14 days, and a license to travel at its expiry).
2. No cattle to graze on crown pastures without license.
3. No bull above one year old to be allowed to graze on public pasture ground.
4. Castration by the European plan.
5. Owners to report sickness to head man who inspects, segregates, and reports to agent.
6. Locality to be placed in quarantine and cattle movements through it prevented.
7. This restriction to be removed only by Government agents or competent authority.
8. Hospitals, medicines and keepers to be provided and appointed.
9. Owners to pay for keep and treatment.
10. Tavelams to be subject to inspection and restriction if necessary.
11. Rules suitable to each province to be made by the agent and proclaimed.
12. Finally, the appointment of a special officer with suitable qualifications, and the training of a special native agency to put these principles into practice are recommended.

The foregoing is a brief sketch of the Ceylon report, which, *mutatis mutandis*, reveals very much the same conditions as regards stock and their diseases as the foregoing pages. The conclusions and recommendations are therefore valuable aids in arriving at a solution of the great problem of prevention. The report differs from the Madras reports in giving only results of inquiries and suggestions as to future action, and no record of any action adopted or work done. This should undoubtedly be the object and burden of all future records of contagious murrains among cattle.

G. I. C. P. O.—No. 1398 R. & A.—17-11-96.—2100—W. B. G.

O. 551-594.

(Vegetable Product Series, No. 22.)
(Dyes and Tans.)

THE AGRICULTURAL LEDGER.

1896—No. 9.

TERMINALIA CHEBULA.

[*Dictionary of Economic Products, Vol. VI, Pt. IV.*, T. 325]

ACACIA ARABICA.

[*Dictionary of Economic Products, Vol. I.*, A. 101.]

CASSIA AURICULATA.

[*Dictionary of Economic Products, Vol. II.*, C. 741.]

TANNING MATERIALS.

Brief Statement of the Imperial Institute Inquiry (No. 46 in the Report on Collections for 1895-96), showing progress made up to June 15th, 1896.

Tanning Materials.

This inquiry (No. 46 in the Report on Collections for 1895-96) may be said to have commenced with **Mr. Royle's** demi-official letter, dated 18th January 1894, which made certain proposals regarding Tanned Skins, and submitted an interesting report by **Messrs. Eales, Rutherford & Co.** of Madras. *Origin of the Inquiry.*

The investigation assumed greater interest and importance, however, with the letter No. 48 F. S., dated the 8th June 1895, from the Imperial Institute, by which **Sir Frederick Abel** intimated that the subject of Tanning Materials had for some time past engaged the attention of the members of the Research Department, and that "the results obtained vary very considerably as regards the proportion of tannin in one and the same product. In some instances this may be due to the conditions under which the materials have been grown in the different Presidencies; in others, possibly, to the variation in age of the plant from which the samples have been taken. Thus in the case of **Cassia auriculata** from Cuddapah, Madras, the proportions of tannin range from 7 to 11 per cent, while a sample of the same plant, examined by **Mr. Procter** of the Yorkshire College, Leeds, contained as much as 18 per cent. Specimens of the fruit from **Terminalia Chebula**, supplied from Madras, Bengal, the North-West Provinces

and Bombay, have furnished percentages of tannin ranging from 13·3 to 38·9. This great variation may, of course, be in a great measure due to the circumstances surrounding the cultivation* of the plant in the different Presidencies, but it may also be due to variations in the maturity of the fruit. It would be very desirable if, in the collection of samples for transmission to the Institute, as full particulars as possible were given in regard to the conditions under which the plants are grown, and in regard to the age of the plants or maturity of the fruit, etc., as we may then be able to throw light upon the conditions and period most favourable to the collection of the material and the maximum percentage of tannin which the particular plant, etc., is capable of yielding."

This letter was replied to by Reporter on Economic Products in his No. 1002—XVI-61, dated the 8th August 1895, No. 15 F. S., stating that the proposed investigations seemed highly desirable. That although some experts regarded the Jabalpur Myrobalan of trade as entirely different from the ordinary Chebulic nut, there could be little doubt that the unfavourable opinions often passed on Indian Tanning Materials proceeded from different parcels having varying proportions of the active principle. The letter then proceeded to describe the measures that would be taken to procure specimens for further examination at the Imperial Institute. See Circular Note No. 46 of 1895-96 reprinted below.

In connection with the inquiry the **Rev. Mr. Campbell** was asked, in letter No. 852, dated 19th July 1895, if he would take steps to collect Myrobalans from the same individual tree of **Terminalia Chebula**, at different stages of growth, *viz.*, ⅓ of the fruit when unripe, ⅓ when fully ripe, and ⅓ when these have fallen to the ground.

Register No. 7429. „ 7429a. This was acknowledged by **Mr. Campbell** in his letter dated 30th July 1895, who promised to collect the Myrobalans as requested.

On the 8th April 1896, **Mr. Campbell** forwarded with his letter of that date the following quantities of **Terminalia Chebula**:— Half-ripe fruit, 2 bags; fully ripe fruit, 1 bag. Regarding these **Mr. Campbell** was asked (demi-official No. 1174—XVI, dated 25th April 1896) if he would kindly furnish information on the following points:—

(1) Season when the half-ripe fruit was collected.
(2) Ditto ripe ditto.
(3) Whether or not they were off the same trees.
(4) Method adopted in drying the fruits.

With the letter was enclosed for easy reference a copy of Circular Note, No. 46 of 1895-96. **Mr. Campbell** replied (letter dated 8th May 1896) as follows:—" (1) The Myrobalans are not all off one tree, but the trees from which they were gathered are all growing within an area of 8 or 10 acres, and are all in the same kind of soil. The trees appear to be the same botanically, so that for your purpose the fruit being from different trees should make no difference. Half-ripe and fully ripe

* Never cultivated.—Ed.

fruits are from the same trees. (2) The trees flower in April, and the half-ripe fruit was collected in the beginning of September, and the ripe fruit on the 1st November. (3) The fruits, both half-ripe and ripe, were spread out in the sun on the roof of my house, and left there till dry. I shall be glad to hear the result of the examination of the Myrobalans."

With a view to obtain information upon the questions raised in the F. S. letter quoted above, the following Circular Note, No. 46 of 1895-96, was then issued to the Conservators of Forests in Bengal, Madras, Bombay, Central Provinces, Panjab, North-West Provinces and Burma :—

Note No. 46 of 1895-96.

Collections for the Imperial Institute, London, and the Indian Museum, Calcutta. Circular Note.

Tanning Materials.

The scientific investigation of the various tanning materials supplied from India to the Imperial Institute has confirmed an opinion originally advanced in the Dictionary of Economic Products, *viz.*, that considerable differences exist in the proportion of tannin contained in one and the same product. This may arise from the samples having been collected at different places, or during various seasons of the year, or under diverse climatic conditions. In the case of fruits it may arise from the degree of ripeness at which they were collected and in the case of barks in the age of the plant. It is thought desirable that these points be definitely investigated as it appears probable that the trade in these articles is retarded through want of uniformity in the materials exported. It is proposed to conduct investigations during the present year with three tanning substances, *viz.* :—

Terminalia Chebula,
Acacia arabica, and
Cassia auriculata.

I. Terminalia Chebula.

Dictionary of Economic Products, Vol. VI., Pt. IV., T. 325-348.

As stated before, considerable difference has been found to exist in the proportion of tannin contained in the fruits of **Terminalia Chebula** obtained from different places. Specimens supplied from Madras, Bombay, Bengal and the North-Western Provinces furnished percentages of tannin ranging from 13 to 38. To ascertain the cause of this difference, it has, therefore, been found necessary to procure samples of the fruit in the following way :—

Six localities should be selected in different parts, the places selected being such as to fairly represent climatic and soil variations. In each

Circular Note.

locality three myrobalan trees should be set apart, *viz.*, (*a*) a young tree, (*b*) a fairly mature tree, and (*c*) an old tree. When the season arrives, one-third of the fruits of each tree should be gathered when half-ripe, one-third when ripe, and the last third when over-ripe, *i e*, when the fruits have fallen to the ground. Each third should be recorded separately for (*a*), (*b*), and (*c*).

One individual tree would not probably afford a very large number of fruits, but it is believed that enough may be got for the purpose of chemical analysis. To still further solve the question of degree of maturity, a large quantity of fruit at each of the three stages of growth should be collected from a number of trees, not from an individual tree. Each specimen should be put in a separate bag bearing a separate number. A note should accompany the specimens containing the following information :—

(*a*) Nature of each specimen and the kind of tree from which it has been collected.
(*b*) Date on which the specimen is collected and the locality where the tree grows.
(*c*) Estimated quantity of the fruit annually available, time of the year when available, and the price at which it can be delivered at the nearest railway station or port.

II. Acacia arabica.

Dictionary of Economic Products, Vol. I., A. 101-134.

With **Acacia arabica** it is proposed to deal with the bark mainly. As in the case of **Terminalia** three kinds of trees should be selected in one and the same locality, *viz.*, (*a*) young, (*b*) fairly mature, and (*c*) old. The bark from these trees should be collected in the following months :—

(*a*) In January.
(*b*) In March, when the tree is in flower.
(*c*) In May or June, when the ripe pods are on the tree.
(*d*) In September, when the sap begins to ascend.

Each specimen should be separately kept, labelled and numbered. A descriptive Note should accompany the specimens, containing similar information as in the case of **Terminalia Chebula.**

III. Cassia auriculata.

Dictionary of Economic Products, Vol. II., C. 741.

Of **Cassia auriculata** the bark should be obtained from a selected number of localities, and the collection should be of such a nature as to exemplify the effects of the age of the plant, season of gathering the bark and local peculiarities of the region of production. A descriptive Note like that required for **Terminalia Chebula** and **Acacia arabica** should accompany the specimens.

The chemical examination to which the bark of **Cassia auriculata** was subjected in England disclosed considerable variation in the amount of tannin contained in the specimens received from different places. Thus, in the bark sent from Cuddapah, Madras, the proportion of tannin ranged from 7 to 11 per cent., while another sample examined by

Mr. Proctor was found to contain as muchas 18 per cent. It is hoped that the investigation now set on foot will once for all decide the question as to the cause of this difference.

It is notnecessary that the experiments with the three products mentioned above should be made in every Province. The following distribution of the work is, therefore, suggested :—

Terminalia Chebula experiment may be made in Bengal, Central Provinces, Madras and Bombay.

Acacia arabica in Bengal, North-Western Provinces, Panjab and Sind.

Cassia auriculata in Madras, Bombay and Berars.

With his letter No. 14—68, dated the 1st January 1896, Sir Frederick Abel forwarded copy of a Memorandum by the Senior Assistant Chemist in the Research Department of the Imperial Institute on the subject of the examination of Indian tanning materials. In that letter it was pointed out that the Memorandum gave numerical results obtained with **Terminalia Chebula, Acacia arabica, Cassia auriculata, Alnus nitida,** and **Ceriops Roxburghiana.**

The Memorandum may be here given as it contains much of practical interest to the Tanning Industries.

Some Indian Tan-Stuffs.

By **R. L. Jenks, F.C.S.,** *Chemical Assistant in the Research Department.*

Memorandum on some Indian Tanning materials.

The Empire of India, it need hardly be remarked, is rich in trees and plants which yield valuable tanning materials of great variety, and in abundance. They are, for the most part, unknown to the markets of Europe, with the notable exception of the *Myrobalan*, which is the fruit of one or other of the three species of **Terminalia.** Specimens of many barks, quite unknown or unused in this country, were exhibited in the Indian and Colonial Exhibition of 1886, and a fine series of samples is to be seen in the Indian Court of the Imperial Institute-collections. Although the reputation of these barks as tanning materials is thoroughly established in India, their application is more or less empirical. The amount of tannin contained in many of them is entirely unknown, and, in the case of others, although definite knowledge on this point has been obtained by chemical examination, yet it has been found that the results of analyses made of a few specimens of which the history is unknown, may be rather misleading than instructive, owing to the variation of the percentage of tannin obtained from different samples of one and the same material, and to the absence of information as to the probable causes of that variation.

Tannin is usually classed as a waste product in the economy of plant life; but it certainly appears to have this distinguishing character—that it is constantly passing away, in the plant, from the seat of formation, *viz.*, from the leaves and green parts which are exposed to light, towards the interior of the plant, where it is believed to assist in the development of nitrogenous bodies. True waste products, on the other hand, appear to be transmitted towards the deciduous extremities, and so got rid of. Tannin is consequently a somewhat fugitive substance in the plant;

moreover, in certain seasons the process of transmission appears to exceed that of formation in activity. It follows that the leaves, bark, fruits, etc., collected under the idea that they are highly charged with the astringent principle, may, at times, be almost void of it. The commercial consequence is obvious, and it may easily happen that the actual practical value of a tan-stuff of recent introduction into a fresh market, may be entirely ruined by the accident of the first samples having been collected under exceptional conditions. It is, therefore, highly desirable to obtain accurate information as to the "tannin-habit" of any tree, or plant, yielding that natural product, and this can only be obtained by the chemical examination of a long series of samples collected with that object.

As a first step in this direction a selection was made from the samples in the collections, during the examination of which, a method of operation suitable for dealing with an extensive series of specimens has been worked out, in which Mr. H. R. Proctor, of the Yorkshire College, Leeds, has importantly assisted. The results obtained are here published, both as demonstrations of the correctness of that method, and because they are in some cases the first results of chemical examination that are known to have been obtained with these materials.

Method of Examination.—The following is an account of the general method of procedure most suitable for the examination of these tannin-yielding materials:—The materials were first ground to a fine powder in a Burroughs and Wellcome drug-mill. A quantity of this powder sufficient to give about six grams of extractive matter per litre of liquor was accurately weighed out. A thistle-funnel was bent twice at right angles so as to form a siphon, the head of which would just touch the bottom of a beaker of about one litre capacity. The thistle-head was covered with fine muslin secured by a rubber band and placed into the beaker, which was then filled to a depth of two inches with fine sifted sand (previously purified by treatment with hydrochloric acid), so that the thistle-head was buried in the sand. A half-litre of distilled water was placed in the beaker, and the powder having been added, it was allowed to stand for some hours; the outer limb of the siphon was then lengthened to some five feet, by the attachment of the requisite tubing, and the siphon was set slowly working; when the liquor had been drawn off a further quantity was added, about one litre, being sufficient to extract the tannin thoroughly from the powder; but if more appeared to be required a further quantity of about 300 cubic centimetres was added; this was afterwards siphoned off separately and concentrated by evaporation until the total volume of aqueous extract did not exceed one litre. The temperature of extraction was 15° C. Parker and Proctor* have shown that the optimum temperature of extraction for myrobalans is between 60° C. and 70° C., but the earlier experiments in the Research Department were made before the publication of their work, and it was not considered advisable to alter the conditions in these comparative experiments. The total weight of the extractive or soluble matter was determined by evaporating 100 C. C. in a weighed basin, for which purpose round-bottomed nickel basins, 3 inches across, were employed. A convenient water-bath was made by fitting to an ordinary 8-inch saucepan a flat lid of sheet copper with four holes of 2½-inch diameter cut in it. The basins were supported over these on glass rims made by cutting rings from the body of a chipped or damaged beaker. The tannin in the extract was estimated by two methods. One, the "shake" method, involved shaking in a bottle on a rotating machine, a measured volume of the tan-liquor, together with a known weight of purified hide-

* Journal of Soc. of Chem. Industry, July 1895.

powder, filtering and estimating the contents of the filtrate. The other method involved the use of a "hide-powder siphon-filter," the shorter limb of a siphon being expanded into a chamber packed with hide-powder, which removes the tan from the liquor as it passes through it. This latter furnishes results quite as reliable and constant as those given by the first method, so that it was used in all the later examinations. The first 30 c. c. which siphon over are rejected, and the next 50 evaporated in a weighed basin. In this way the amount of tannin material abstracted by the filter from the tan-liquor was obtained. The ash was determined separately by ignition in a platinum dish.

The following results were obtained :—

DESCRIPTION AND No.	Ash %	Total Sol. %	Non Tans %	Tans %	REMARKS.
Terminalia Chebula—					
No. 1093	1·3	54·71	15·77	38·94	Round and inflated fruits.
" 661	1·7	32·80	19·50	13·30	Small, dried, and dark.
" 602	1·91	43·36	24·91	18·45	Long, lean, shrivelled.
" 357	2·14	46·70	19·68	27·02	Small, shrivelled, pale.
Acacia arabica, *babul* pods	...	33·73	24·18	9·55	Husks and seeds.
Cassia auriculata—					
No. 6154	1·03	17·37	6·08	11·29	From small boughs about 1-inch diameter.
" 678	2·97	16·55	16·31	0·24	Root bark.
" 6152	0·82	11·63	4·65	6 98	From young shoots.
" 6151	0·36	15·18	4·96	10·22	From stems 3 years old.
A sample furnished by Mr. Proctor	0·91	18·53	2·21	16·32	
Alnus nitida	0·2	7·63	4·56	3·07	Very short-grained bark.
Ceriops Roxburghiana	0·74	14·88	4 52	10·36	From boughs about 3-inch diameter.

Terminalia Chebula.

Terminalia Chebula.—It will be seen at once that the variations in the percentage of tannin found in the four samples of this material is very great. As noticed by Dr. Watt in the Dictionary of Economic Products of India, the Tanning Conference of the Indian and Colonial Exhibition had the myrobalan under its consideration, and it was then shown that the fruits most esteemed by the trade were those of oval and pointed form, of a pale greenish-yellow colour and solid in structure, while round and spongy fruit were condemned. Dr. Paul undertook to make a special examination of the fruit, and was supplied with three perfectly authenticated samples. The tannin was found to vary in these from 7 to 33 per cent., and the order of value assigned to them by the practical expert was justified by the analyses. It was generally agreed that the tannin in different samples might be expected to vary from 6 per cent. to 33 per cent., but the important work of collating external appearance or age of the fruits with tannin-contents was not then entered upon. The establishment of the Research Laboratory of the Imperial Institute has made it possible for this work to be taken up systematically, and under conditions that, it is hoped, will ensure beneficial results. The variations in the proportion of tannin in the specimens of Terminalia analysed having

been brought under the notice of the Indian Government, it has been decided to collect samples with the specific object of determining the influence upon the amount of tannin exerted by the age (*a*) of the parent plant; (*b*) by the age of the fruit itself; and also as far as possible (*c*) by the locality where the plant is grown. In regard to the results given above, it may be pointed out that the specimen (No. 1093) which possessed most strongly the characteristics condemned by the Tanning Conference, was yet the richest in tannin.

Acacia arabica.

Acacia arabica.—Both the bark and the pods of this tree, the well-known *babul*, contain tannin. An early analysis of the pods shows that the husk or cases alone contain 60 per cent. of tannin, and the seeds themselves practically none. The sample of pods examined in the Research Department contained only 9½ per cent., while two specimens in the possession of Mr. Proctor contained 9 per cent. and 13 per cent., respectively. In all three instances the seeds were not separated, nor would this be likely to prove a very practicable operation upon a large scale. The bark, which is stated to contain 19 per cent. of tannin, is much more largely used in India, but nothing is known definitely of its tannin-habit.

The Indian Government has arranged to gather a complete series of samples of this bark at four periods of the year, and from old and young trees.

Cassia auriculata.

Cassia auriculata.—The bark of this tree is one of the most valuable of Indian tan-stuffs, but its value would probably be increased if more were known of its tannin-habit. The figures above given indicate to what variations in amount of astringent principle, and therefore in commercial value, it may be liable. The Indian Government has decided to obtain a series of authentic samples of this also, to be examined in the same manner as the two last-mentioned tan-stuffs.

The remaining pair of analyses given in the above table are of materials which have a good reputation in India, and are known to confer special and valuable properties on leather treated with them. The results are recorded for comparison, but it is not proposed at present to deal exhaustively with these particular materials.

For the purpose of convenient reference in connection with the collections that have been made or which have been arranged for, the following *précis* of correspondence may be here given, the marginal numbers being the registration numbers of the collections received up to the 15th June 1896:—

Terminalia Chebula.

TERMINALIA CHEBULA.

Bombay.—The Deputy Conservator of Forests, NORTHERN CIRCLE, replied (letter No. 3127, dated 17th December 1895) that **Terminalia Chebula** is found in insignificant quantities only in one Division, and that hence he regretted he could offer no assistance.

This was acknowledged (No. 743—61) by asking, in the event of the people in the Northern Circle, Bombay, using any other special tanning material, whether the Conservator would be prepared to furnish a supply for analysis. It was explained that the chemical examination of a small sample of *Hirda* (**Terminalia Chebula**)

BOMBAY.

would be of value, even though commercial results might not be anticipated.

The Conservator of Forests, CENTRAL CIRCLE (letter No. 5910, dated 17th December 1895) stated that he was prepared to undertake the preparation of the collections indented for.

Existing Trade.

The Conservator of Forests, SOUTHERN CIRCLE, replied (letter No. 6154, dated 7th January 1896) that **Terminalia Chebula** occurs very extensively all along the Ghats and about 2,200 tons of the fruit are collected annually. He added that it was impossible to procure the required fruits before November next, as these cannot be dried in sufficient quantity before the beginning of the dry season. The Conservator suggested that it might suffice if fallen nuts were collected and kept separate from nuts gathered from the tree. He considered that, not being a garden industry in which minute details can be attended to, it was useless to distinguish between the produce of old and young trees. He would in connection with the specimens supplied note the month of collection, and remarked that fruit collected late might be compared with that collected early in the season from the same tree. The Conservator does not consider the question of age of the tree as likely to affect the quantity of tannin, nor does he regard it as necessary to examine the fruit from different localities. "What is true for one will be true for another." But he adds—

"There are in this district two distinct kinds of fruit—a big oval one, and one that is small and more elongated. The latter fetches a better price in the market, and is I believe known in the trade as *Jabalpur hirda.*"

This was replied to by Reporter on Economic Products (No. 388—61, dated 25th February 1896) to the effect that the rules laid down were framed in order to solve chemical difficulties and were made at the request of the home chemical authorities; that the results of the inquiry might be of purely chemical interest or might have a very great commercial significance. The fact noted by the Conservator regarding the long narrow pointed Chebulic Myrobalan (Jabalpur Myrobalan) being the more valuable, confirmed the previously recorded opinion. Conservator was asked for 1 cwt. of each of the two forms mentioned by him. In reply the Conservator in his letter (No. 7533, dated 5th March 1896) promised to meet the indent to the best of his ability.

The Divisional Forest Officer, Belgaum (SOUTHERN CIRCLE), wrote (letter No. C-406, dated 7th March 1896) that the season was too far advanced to collect the required information, but he would do his best in November next, and that meantime he would collect specimens of the flowers. The same officer wrote (letter No. G-65, dated the 5th May 1896) and forwarded 12 botanical specimens of **Terminalia Chebula** collected in different parts of the district. He added that the trees from which the specimens were taken have been marked and that the fruits will be collected and sent when ready.

CENTRAL PROVINCES.

Central Provinces.—The Conservator of Forests, SOUTHERN CIRCLE, Nagpur, replied (letter No. 527 M., dated 18th December 1895)

CENTRAL PROVINCES.

that he would endeavour to collect the desired specimens. He remarked that in his opinion the difference noted is owing mainly to the very imperfect agency employed in collecting the product, jungle tribes being generally careless as to proper time of collection—when the fruit is ripe—and also in storing after collection.

This was acknowledged (No. 744—61, dated 14th March 1896) by asking that of two maunds collected of each form, one maund might be exposed to rain, in the exact way pursued by the natives, in order to determine the results of bad curing, but that the other maund should be carefully dried. The Conservator of Forests, NORTHERN CIRCLE, CENTRAL PROVINCES, replied (letter No. 8542, dated the 26th December 1895) that he would conduct the desired experiments.

N.-W. P. & OUDH.

North-West Provinces and Oudh.—The Conservator of Forests, OUDH CIRCLE, by his letter No. 1084 C., dated the 19th March 1896, reported that he had addressed the Forest Officers of Kheri and Bahraich and requested them to take early action.

By his letter No. 551, dated 31st March 1896, the Conservator of Forests, CENTRAL CIRCLE, replied that none of the trees producing these materials are found in quantity in that Circle.

The Conservator was informed (No. 1149—61) that the chemical analysis of the specimens asked for, though of no commercial interest, would be of the utmost value as showing effect of climate or soil in a region presumably not suited to these trees. He was, therefore, invited to contribute the specimens in such quantity as could be conveniently procured. By his endorsement No. 68, dated 5th May 1896, the Conservator of Forests, CENTRAL CIRCLE, wrote that the officer in charge of the Kumaun Division had been requested to contribute specimens of the fruit of **Terminalia Chebula.**

The Extra Assistant Conservator of Forests, SAHARUNPUR DIVISION, explained, in his letter No. 83, dated the 2nd June 1896, that the season having been exceptionally dry, the fruits began to ripen and fell to the ground in April. He asked what quantity of these over-ripe fruits should be sent.

Acknowledged by letter No. $\frac{2132}{61}$, dated 14th July 1896, in which he was asked to supply 10 seers of the over-ripe fruits.

The Conservator of Forests, SCHOOL CIRCLE, replied (letter No. 1314, dated 16th March 1896), and promised to do his best, but suggested that the experiment might be carried out in a locality where the tree is common, since in that Circle the fruit is collected and used locally only.

This was acknowledged (No. 904—61, dated the 30th March) by stating that the authorities in England desired the fruits to be furnished from as wide an area as possible, so that the influence of climate or soil on the production of tannin might be tested. This was replied to by the Conservator in his letter No. 9, dated the 7th April 1896, in which he pointed out that the North-West Provinces were not included originally in the list of localities from which specimens

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were required, but that he would endeavour to procure a supply as desired.

Madras.—The Conservator of Forests, CENTRAL CIRCLE, replied (letter No. 1545, dated 18th December 1895) approving of the inquiry and promising to undertake the collection.

The Conservator of Forests, NORTHERN CIRCLE (letter No. R C. 1226, dated 30th January 1896) reported that he had taken steps to procure the collections. In his opinion the variation in value of myrobalans is due to the careless way in which the fruit is gathered. Much is collected in a green state, by lopping the branches and the fruits at once dried in the sun; again, large quantities are gathered up more or less charred after forest fires. In wet districts, such as Malabar, the fruit is often damaged by rain. The best specimens would doubtless come from Nellore, where the Yanadis, a forest tribe, collect the fruit for Government.

The Conservator was thanked for his interesting letter (reply No. 387—61, dated the 25th February 1896), and informed that while the irregularity in collection of myrobalans is possibly the chief defect, it is not yet known whether unripe or ripe fruits are the richer in tannin. It is desired to be able to say whether the green fruits gathered from the trees are better or worse than the ripe fruits collected from the ground.

The Acting Conservator of Forests, SOUTHERN CIRCLE, replied by his No. 2326, dated 11th May 1896, that he had asked the District Forest Officer, Madura, to arrange for the experiments with **Terminalia Chebula.** He also enclosed the following return from the District Forest Officers of the Circle reporting the estimated yield of fruits in their Districts:—

ABSTRACT OF RETURNS FROM DISTRICT FOREST OFFICERS OF THE ESTIMATED YIELD IN GALLNUTS.

Estimated Production.

South Canara.—The quantity of Myrobalan exported from ports during the last five years was as follows:—

Year.	Whither exported.	Quantity. Cwt.	qr.	lb
1890-91	Bombay and certain other B. and I. Ports	4,037	2	0
1891-92	Ditto ditto ditto	3,041	1	14
1892-93	Ditto ditto ditto	1,743	0	0
1893-94	Ditto ditto ditto	2,344	1	0
1894-95	Ditto ditto ditto	1,609	0	0
		12,775	0	14

North Malabar.—Gallnuts are exported in considerable quantities from Rampur and Maranhalla Blocks and sold at Gundulpett—probably 10 tons annually.

South Malabar.—Gallnut, Myrobalan, is not exported from this Division.

TERMINALIA Chebula. **Brief Statement of the**

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Nilgiris.—Is reported to be exported chiefly to Coimbatore and the Mysore Territory, the average quantity exported in each year being about 1,000 maunds.

Note.—1 maund = ℔960 weight.

North Coimbatore.—In all, the Minor Forest Produce Contractor collected 712 *pothies* (of 192 Madras measures each) in the past two years in the hill forests, and they were sold locally and exported to Madras and Bombay.

Note.—1 Madras measure = ℔120 weight.

South Coimbatore.—About 1,600 maunds of gallnuts are collected every year, of which about ½ is exported to Madras, ⅙ to Salem District, and the rest consumed in the district.

Madura.—The average annual yield will be about 16,500 maunds, Kodaikanal and Tandigudi Ranges contributing the largest number and Kanavoypatti the least. It is not exported beyond Dindigul, where it finds a ready sale, fetching about R1 per maund. It is used in several tanneries for tanning leather.

Tinnevelly.—Approximately 42,310℔ of ordinary gallnut is annually exported to Bombay and Dindigul from 5 of the taluks in the district. The produce is leased out to contractors, and is bought from them by local merchants who export it to Bombay and Dindigul The quantity of local consumption is not ascertainable, but it will be very small. The demand appears to be for the purpose of tanning leather.

The District Forest Officer, CUDDAPAH, wrote (letter No. 2026—21-5-96, dated the 17th May 1896) that the specimens of **Terminalia Chebula** cannot be supplied at once, but will be sent in the early part of 1897.

In letter No. 3135—499 En. 2, dated 1st April 1896, the Conservator of Forests in MYSORE stated that specimens had been ordered. He also reported having received certain supplies from the French Rocks Sub-Division, and inquired if these were to be forwarded under the circumstances mentioned in the copies of two letters which he enclosed. These were—letter No. 804, dated 21st February 1896, from Sub-Divisional Forest Officer, French Rocks, forwarding about 60 Mysore seers of myrobalans in three bags, as under:—

Register No. 7628, „ 7628a, „ 7628b.

No. 1. Unripe fruit.
„ 2. Fully ripe.
„ 3. Over-ripe and fallen fruits.

All being the produce of about 20 selected trees in the maidan forest of Naraindrug. The instructions issued were misunderstood by the Forester who mixed together the fruit of all the selected trees, but fortunately kept separately the fruits collected during the three separate stages of growth. The Sub-Divisional Forest Officer promised a more carefully selected collection during the next season. The same officer wrote under date 24th February (No. 815) to the District Forest Officer, Mysore, that on repacking the myrobalans, it was observed that the sample marked unripe did not appear so, not being shrivelled up, as tender fruit should be, when gathered in an immature state and dried. Enquiry being made, the Forester stated

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that 'as the sample was collected when in a little riper condition, it had not the shrivelled-up appearance.' The letter concludes by stating that the Brahmins of Melukota make a pickle of the very tender myrobalans.* The Conservator of Forests, Mysore, by No. 1150—61, dated 24th April 1896, was asked to send the specimens referred to. By his letter No. 697, dated the 3rd May 1896, the Deputy Conservator of Forests, SHIMOGA DISTRICT, Mysore, forwarded 4 bags of Myrobalans, and stated that, according to the instructions contained in this office Circular Note No. 46 of 1895-96, the collections from 1 selected tree and 20 other trees were made at three different times, and kept distinct from one another. One bag contains 3 specimens of 1 selected tree packed separately and labelled as shown below:—

Samples Received.

No. 1. Unripe fruits of one tree.
„ 2. Fully ripe ditto.
„ 3. Over-ripe fruits fallen to the ground.

Register No 7493. „ 7494. „ 7495.

Three other bags contain three sets of fruits of 20 trees as noted below:—

No 4. Unripe fruits of 20 trees.
„ 5. Fully ripe ditto.
„ 6. Over-ripe fruits of 20 trees fallen to the ground.

No. 7493a. „ 7494a. „ 7495a.

Mysore.—The District Forest Officer, HASSAN, in Mysore, with letter No. 230-Mis., dated 23rd May 1896, forwarded the following packages of Myrobalans collected in accordance with the instructions given:—No. 1, unripe fruit; No. 2, fully ripe fruit; and No. 3, over-ripe fruit fallen to the ground. The collection was made as follows:—Twenty trees were selected, and a third part of the fruit from each of these trees was collected when unripe, mixed up and kept apart. When the first collection was finished, there thus remained ⅔ of the fruits on each tree. The second batch of fruit was collected when these were fully ripe from each of the 20 trees and kept separate from the first batch collected. The remaining third of the fruits from the 20 trees in question was picked up when they were over-ripe and fallen to the ground. This last batch was also preserved separate from each of the first two.

Register No. 7868. „ 7868a. „ 7868b.

Hyderabad, Deccan.—The Conservator of Forests, His Highness the Nizam's Dominions, by his letter No. 139, dated the 3rd June 1896, forwarded two samples of **Terminalia Chebula** fruit as follows:—No. 1, over-ripe fruit picked up from below the trees. No. 2, ripe fruit gathered from the same trees. The trees in question were about 20 inches in girth and probably 12 years old. The fruit was collected on 22nd April 1896 at Redepally in the Madhapur Taluk on the banks of the Godavery. The fruit on the larger trees had all been gathered during March.

Register No. 7718. „ 7718a.

Bengal.—The Conservator of Forests, Bengal, replied by his letter No. 13 T. P.-m., dated the 15th April 1896, that experiments would be carried on in his Circle.

BENGAL.

* This fact is alluded to by JOHN HUYGHEN VAN LINSCHOTEN in his Travells published in 1596.—*Ed.*

BURMA.

Burma.—The Officiating Conservator of Forests, Pegu Circle, Rangoon, replied (letter No. 2698—54-1, dated Camp, the 28th March 1896, and again by a further letter No. 2649—41-28 under same date). These were replied to by the Reporter's letters Nos. 1152—61, dated 24th April, and 1176, of the 25th April 1896. The Conservator wrote that there are two articles of forest produce in this part of India which are now entirely unutilised, but which might easily be rendered marketable, *viz.*, Myrobalans (*Panga-thi*) and the seeds of **Strychnos Nux-vomica** (*Kabaung-thi*). The letter suggested that the Reporter should draw up a note regarding the preparation of these for the Indian or home markets, and added that the information may probably be of use in assisting the rural population to tide over the years of scarcity that sometimes occur in Upper Burma from drought and in Lower Burma from inundations. Attention was drawn to the fact that the climate of Lower Burma is very damp, from May till October, and that of the Central zone of Upper Burma just the reverse. It was added that efforts were made in 1891 by the Bombay Burma Trading Corporation, Limited, to inaugurate a trade in Myrobalans, but it is understood that the proper seasoning of the fruit was the main difficulty.

The Reporter replied that the Conservator's suggestions would have early consideration. The position of affairs regarding Myrobalans was then briefly stated and the Conservator invited to give the subject his favourable consideration, and to furnish such samples and information as he could do conveniently.

The Officiating Conservator of Forests, Tenasserim Circle, Rangoon, replied (letter No. 2090, dated 19th March 1896) that unless the matter was considered of great importance he would suggest that the experiments referred to be confined to the other Provinces enumerated in the Note. To this the Reporter replied that it had been considered highly probable that the inquiry in Burma may lead to useful results. The letter concluded by asking the Conservator, if at all possible, to comply with the indent, and, if unable to deal with the matter fully, to supply such collections as he could conveniently procure. The Conservator of Forests, Western Circle, Upper Burma, wrote (letter No. 14—5 G.-8, dated 1st April 1896) that a variety of **Terminalia Chebula** grows largely in the Pakokku, Minbu and Magwé Districts in this Circle, but that it appears to be different to the Indian **Terminalia Chebula** and not to have the same tannin properties. Kurz he says calls it **Terminalia tomentella**, and mentions that its fruit produces ink inferior to **Terminalia Chebula.**

In reply the Conservator was asked (by letter No. 1148—61, dated the 24th April 1896) to furnish specimens of the **Terminalia Chebula** *var.* **tomentella** alluded to by him and in sufficient quantity for comparative analysis, alongside of similar specimens from other Districts, in accordance with the indent specified in the original printed circular.

Mangosteen husk.

In connection with the present inquiry mention may be here made of an interesting letter No. 2653—41-28, dated 20th March 1896, received from the Conservator of Forests, Pegu Circle, on the subject

BURMA.

Mangosteen husk.

of the husk of the Mangosteen fruit. He there calls attention to the valuable tanning and dyeing properties of that article, and states that the juice of the husk makes an indelible stain on any article such as linen, etc., with which it happens to come in contact while fresh. He further states that hundreds of thousands, probably many millions, of the husks of this fruit are annually thrown away in Moulmein, Tavoy, Mergui, and the southern parts of the Tenasserim Division of Burma, as well as in Penang and Singapore. The climate of Tenasserim being very moist from about the 20th April onwards, there may be difficulty in drying the husks, but this difficulty should not be insurmountable, and experiments might well be made from April when the fruit will come into season. The Conservator regrets that the Mangosteen not being indigenous to the Pegu Forest Circle, he is unable to render any assistance further than to call attention to the possibilities possessed by this raw material which is at present entirely wasted.

Reply was made by Reporter on Economic Products, No. 1151—61, dated 24th April 1896, in which he thanked the Conservator for his interesting letter, and stated that an application had been forwarded to the Conservator of Forests, Tenasserim, asking for a sufficient quantity to allow of analysis. If supplied, it would be forwarded to the Imperial Institute for that purpose and a copy of the report when received furnished to the Conservator. The Conservator of Forests, EASTERN CIRCLE, wrote (letter No. 281—36 A 6, dated 7th May 1896), that there is nothing on record to show that **Terminalia Chebula** has ever been found in that Circle.

ACACIA arabica. Brief Statement of the

ACACIA ARABICA.

BOMBAY.

Bombay.—The Conservator of Forests, SOUTHERN CIRCLE, by his letter No. 6154, dated 7th January 1896, replied that **Acacia arabica** is not grown to any great extent in this Circle.

CENTRAL PROVINCES.

Central Provinces.—The Conservator of Forests, SOUTHERN CIRCLE, reported (letter No. M.-527, dated $\frac{18th}{23rd}$ December 1895) that **Acacia arabica** is not found as a forest plant in this Circle.

N.-W. P. & OUDH.

North-West Provinces and Oudh.—The Conservator of Forests, SCHOOL CIRCLE, replied (letter No. 1314, dated the 16th March 1896) that **Acacia arabica** does not occur in the Forests of this Circle, and the Conservator of the OUDH CIRCLE, by his letter No. 1084 C., dated the 19th March 1896, also wrote to the same effect.

The Conservator of Forests, CENTRAL CIRCLE, replied (letter No. 551, dated the 31st March 1896), that **Acacia arabica** is not found in quantity in the Forests of this Circle. He added that it is met with most abundantly in the Berars and the Bombay Presidency. This was answered by letter No. 1149—61, dated the 24th April 1896, which invited the Conservator to contribute specimens in such quantities as he could conveniently procure. By his endorsement No. 68, dated 5th May 1896, the Conservator stated that the Officer in charge of the Bundelkhand Division had been requested to contribute specimens of the bark of **Acacia arabica**.

PANJAB.

Panjab.—The Officiating Conservator of Forests replied (letter No. 2779, dated the 3rd January 1896) that he would collect specimens and forward these in due course.

BENGAL.

Bengal.—The Conservator of Forests wrote (letter No. 13 T.P.-m., dated the 15th April 1896) that **Acacia arabica** is not found sufficiently abundant in the Forests of this Circle to allow of the proposed experiments.

MADRAS.

Madras.—The District Forest Officer of KADUR, in Mysore, by his letter No. 334, dated the 19th February 1896, forwarded the follow ing consignments of *babul* bark (**Acacia arabica**) :—

Register.	No. of Samples.				
No 7140	4	Nos. 1-4	A—Samples of bark from	well-grown *babul* trees.
" 7141	4	" 12-15	B—	Ditto.	very young trees.
" 7142	4	" 8-11	C—	Ditto.	a very old tree.
" 7143	3	" 5-7	D—	Ditto.	branches pollarded.

A copy of letter No. 277, dated the $\frac{6th}{10th}$ January 1896, from Deputy Conservator of Forests, Kadur District, to the Conservator of Forests in Mysore, was also forwarded for information. In that letter the Deputy Conservator states:—On the 22nd October I received your order No. 990—52, dated the 11th October 1895. On the 30th idem I personally marked a number of *babul* trees in the Birur Kaval, and had serial numbers put upon 20 of about the same apparent age. On the following day I personally superintended the

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stripping of the bark and its removal to the travellers' bungalow in Kadur in bags, some work which remained to be done being completed by my Forester the next day when I formed the under-mentioned samples :—

A—Bark from trees in the prime of life.

B— Ditto. very young trees.

C— Ditto. a very old large tree.

D— Ditto. the branches.

These samples, in order to prevent any possibility of admixture during dryage, were sent to four different depôts where they are now ready for forwardal whenever desired. I deemed it advisable to form a separate sample of green branch bark from A, since the pollarding of *babul* trees is so much in vogue here, and I also ascertained by weighment that the proportion of green branch bark to the whole is nearly 10 per cent., while the average total yield of a tree is 266lb, *i.e.*, 240lb of A and 26lb of D. The trees numbered but not used in this first stripping are left standing for future felling and stripping. On the date of felling and barking, *viz.*, the 31st October, the trees bore both flowers and well-developed green pods.

BURMA.

Burma.—The Conservator of Forests, PEGU CIRCLE, replied (letter No. 2698, dated 20th March 1896) that **Acacia arabica** does not occur in this Circle to any extent capable of becoming commercially important. Acknowledged by letter No. 1152—61, dated the 24th April 1896, inviting the Conservator to be so good as to furnish as large samples as he could conveniently procure.

The Conservator of Forests, WESTERN CIRCLE, wrote (letter No. 14—5 G.-8. dated 1st April 1896) that **Acacia arabica** is not known to occur wild in Upper Burma.

CASSIA AURICULATA.

BOMBAY.

Bombay.—The Deputy Conservator of Forests, NORTHERN CIRCLE, replied (letter dated the 17th December 1895, No. 3127) that the *Tarwad* (**Cassia auriculata**) is not found in the Forests of that Circle.

The Conservator of Forests, CENTRAL CIRCLE (letter No. 5910, dated the 17th December 1895), stated that he would undertake the collection required.

The Conservator of Forests, SOUTHERN CIRCLE, replied (letter No. 6154, dated the 7th January 1896) that **Acacia arabica** [and from the context it is presumed **Cassia auriculata** also] is not a tree which can be grown to any great extent in the Southern Circle, as the land on which it occurs is more valuable for agricultural purposes than for tree-growing. He adds that the Conservator of the Central Circle could very possibly supply samples of **Cassia**.

The Divisional Forest Officer, EAST KHANDESH, forwarded with letter No. 3—620, dated the 5th February 1896, a parcel of pounded bark of **Cassia auriculata** (*Tarwad*) which the '*Chambhars*' in this country use for tanning leather.

CENTRAL PROVINCES.

Central Provinces.—The Conservator of Forests, SOUTHERN CIRCLE, replied (letter No. M.-527, dated the $\frac{18\text{th}}{23\text{rd}}$ December 1895) that **Cassia auriculata** is not found as a forest plant in this Circle.

N.-W.-P. & OUDH.

North-West Provinces and Oudh.—The Conservator of Forests, SCHOOL CIRCLE (letter No. 1314, dated the 16th March 1896) stated that **Cassia auriculata** does not occur in the Forests of this Circle.

The Conservator of Forests, OUDH CIRCLE, reported (letter No. C.-1084, dated the 19th March 1896) that **Cassia auriculata** is not met with in that Circle.

The Conservator of Forests, CENTRAL CIRCLE, replied (letter No. 551, dated the 31st March 1896) that **Cassia auriculata** is not found in quantity in the Forests of that Circle. This was acknowledged by letter No. 1149—61, dated the 24th April 1896, in which the Conservator was invited to contribute specimens of **Cassia auriculata** in such quantities as he could conveniently procure. The Conservator, by his endorsement No. 68, dated the 5th May 1896, informed this office that the Officer in charge of the Garhwal Division had been requested to contribute specimens of **Cassia auriculata**.

MADRAS.

Madras.—The Conservator of Forests, CENTRAL CIRCLE, approved of the inquiry and undertook the collection (letter No. 1545, dated 20th December 1895).

The circular was replied to by the Conservator of Forests, NORTHERN CIRCLE, letter No. 1226 R. C., dated 30th January 1896, who stated that steps were being taken to make the collections. The Conservator added that in his opinion the difference in value probably arises

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from the fact that there is a greater proportion of tannin in protected shrubs. He has been confirmed in this view by observing the prices paid by merchants as it has seemed to him that the rates advanced in proportion to the protection which would seem to indicate that immature shrubs yielded poorer bark. He concluded by stating that the relative ease of stripping the bark from larger shrubs may of course have had something to do with the higher rates offered. In reply the Conservator was informed (letter No. 387—61, dated 25th February 1896) that his observation as to the superiority of the bark from protected bushes is on the lines of the present inquiry. It is desired to know whether old or young bushes yield most tannin. Protected bushes would very possibly be older than those not protected. It will be possible to affirm which is best on the supply of specimens collected according to the rules laid down in this office original circular note. The Conservator of Forests in Mysore (letter No. 2241—331, dated 10th January 1896) advised the despatch of five bags of specimens of **Cassia auriculata** (*Tangadi*) bark (as per following extract) collected in the Kolar District in September 1895. Extract, paragraphs 2 to 8, Kolar District Forest Officer's No. 109, dated 28th October 1895 :—Sample No. I has been extracted from fully matured shrubs 6-7 years old, the age being testified to by the annual rings counted on sections of wood. No. II sample is mature for all practical purposes. This is the kind of produce usually available. It is collected and removed from the District and State Forests in large quantities by purchasers. The shrubs are 3-5 years old. No. III is taken from shrubs about 3 years old. This bark is in the stage of maturity, and where more highly mature produce is not available, license-holders do not object to gather the same. It is mixed up with bark of the superior classes above mentioned. No. IV is a sample of 2 years old bark. This is rarely collected by purchasers. No. V is a sample of immature or unripe bark. Sections of wood show only one ring, indicating that the shrub is in the first year of its growth; in fact the autumn zone of the ring has not commenced to form. The age is also confirmed by the fact that the shrubs which yielded the sample have been ascertained to be the coppice shoots of shrubs cut in the demarcation line round Chennarayabetta Forest in November 1894. Two billets of wood are sent with each sample to give an idea of the thickness of the stems from which the bark has been extracted. A sample of soil where the above bark was collected is also despatched in a separate cover.

Register No 7025. 7027. 7029. 7031. 7033. 7025a. 7027a. 7029a. 7031a. 7033a. 7035.

Imperial Institute.—The despatch of a supply of **Cassia auriculata** from the foregoing samples was advised by Reporter on Economic Products' letter No. 1312—58 F. S., dated the 6th May 1896, and copies of the notes received with the samples were forwarded at the same time for information. The letter explained that the present instalment was despatched to allow of the examination being commenced.

The Conservator of Forests in Mysore forwarded, along with his letter No. 3616-588, dated the 28th April 1896, a parcel containing four

CASSIA auriculata. Brief Statement of the

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packets of bark of **Cassia auriculata** collected under different conditions in the Jogimatti Jungle, Chitaldrug Taluk and Holalkere Taluk of the Chitaldrug District. These samples were described in the District Forest Officer's (Chitaldrug) letter as under:—

Register No. 7614. *Sample No. I.*—Bark from mature bush collected in January 1896 from the Jogimatti Jungle.

" 7615. *Sample No. II.*—Bark collected from bushes of different stages of growth in January 1896 from the Joginath Forest.

" 7616. *Sample No. III.*—Bark from 3 years old bushes collected in the Holalkere Taluk.

" 7617. *Sample No. IV.*—Bark from 2 years old bushes collected in the Holalkere Taluk.

BURMA.

Burma.—The Officiating Conservator of Forests, Pegu Circle, Rangoon, replied (letter No. 2698—54-1, dated the 20th March 1896) that **Cassia auriculata** does not occur in that Circle to any extent capable of becoming economically important.

This was acknowledged by letter No. 1152—61, dated the 24th April 1896, inviting the Conservator to be so good as to furnish as large samples as he could conveniently procure in accordance with the printed Circular No. 46.

The Conservator of Forests, Western Circle, replied (letter No. 14—5 G.-8) that **Cassia auriculata** grows here and there in dry districts, but is not common, and its use in Upper Burma for tanning or dyeing purposes is not known to the Conservator.

Answered by letter No. 1148—61, dated the 24th April 1896, stating that the chemical analysis of **Cassia auriculata** from Burma would be of scientific value, and requesting that, if at all convenient, specimens might be furnished.

The Conservator of Forests, Tenasserim Circle, replied (letter No. 2090, dated 19th March 1896), suggesting that unless the matter is considered of great importance the experiments be confined to the Provinces enumerated in Circular No. 46.

This was replied to by letter No. 1332—61, dated the 8th May 1896, that, as it is considered highly probable the inquiry in Burma may lead to most useful results, the Conservator should, if at all possible, comply with the indent. If not able to deal with the matter fully, the Conservator was further informed that such collections as he could conveniently furnish would be very acceptable.

It will thus be seen that, so far as **Acacia arabica** and very nearly **Cassia auriculata** as well are concerned, the results of the present enquiry have been negative. We have been told that these plants do not occur in the forests. That information is doubtless valuable as emphasising the direction in which an extended future trade must be conducted. They are road-side and village plants. The present review has been issued as a key to the collections received up to the 15th June 1896. It is believed that without some sort of abstract of the opinions advanced and particulars as to the conditions under

BURMA.

which the specimens were collected, the Chemist might find it difficult to conduct his investigations. It is now proposed to extend the enquiry to the Agricultural Districts and District Officers, and it may be hoped that ultimately an extensive series of samples will be brought together, and much new and interesting particulars which, when combined with the report to be furnished by the Research Department of the Imperial Institute, will be of considerable value to the people of India.

GEORGE WATT,
Reporter on Economic Products.

G. I. C. P. O.—71 R. & A. D.—24-7-96-2100

(Veterinary Series, No. 19.)
Medicinal Products.

THE

AGRICULTURAL LEDGER.

1896—No. 10.

OXEN AND BUFFALOES.

(CATTLE OF BURMA.)

[*Dictionary of Economic Products, Vol. V.*, O. 551-94.]

Vernacular names used in the Districts of Burma for the Diseases of Cattle, by VETERINARY-CAPTAIN G. H. EVANS, A.V.D., *Superintendent, Civil Veterinary Department, Burma.*

The present paper practically assumes the form of an appendix to Veterinary-Captain G. H. Evans' former paper on THE CATTLE AND BUFFALOES OF BURMA which appeared in *The Agricultural Ledger* No. 10 of 1895.

It would serve a useful purpose were similar list of the vernacular names of the diseases of cattle to be prepared for the other provinces of India.—ED.

O. 551-94.

OXEN — Burmese names for

District.	UNCOM		
	Rabies.	Surra.	Charbon.
(Burmese) . .	Kwe-yu-na .	Ihût . .	Daung-
Pakokhu . .	Do. .	Do. . .	Daungdan .
Minbu . .	Do. .	Do. . .	Daung-byat .
Magwé . .	Do.	Do. . .	Do. .
Thayetmyo .	Do. .	Do. .	Moat-so-le-byit .
Prome . .	Do. .	Do. . .	Hminthet .
Mandalay . .	Do. .	Do. . .	Hauk-na ; Gyeik
Tounghoo . .	Do. .	Thot-pye or Thot-kyauk-pyin.	Daung-than ; Gyeik-na Hauk- or Le-do-na.
Tharrawaddy .	Do. .	Do. .	Hminthet ; Yaing-Hauk-na.
Henzada . .	Do. .	Thot-kyan-sit or Thot-pye or Thot-kyauk-pyin.	Le-lain-na .
Meiktila . .	Do. .	Thot-kyauk-pyin	Hauk-na . .
Yaméthin . .	Do. .	Do. .	Le-do-na . .
Akyab . .	Do. .	None . .	Aung-na or yan-na.

Diseases of Cattle. (*G. H. Evans.*) AND BUFFALOES.

MON DISEASES.

Charbon Symptomatique.	Glanders and Farcy.	Pleuro-pneumonia.	Rinderpest.	Tetanus.
than.	Zaung-gaw .	Asôk-yaw-ga.	Kyauk-pauk	May-kine.
Gyeik . .	Do	Do. .	Do	Do.
Do . .	Do. .	Do. .	Do. .	Do.
Daung-dan .	Do. .	Do. .	Do .	Do
Hauk-na .	Do. .	Do. .	Do .	Do.
Daung-thau .	Do. .	Oo-baw-yē-shan.	Do. .	Do.
Do. .	Do .	Do. .	Kut-na; Kaba-na or Mo-gya-na.	Do.
Yaung-na; na; Haik-na;	Zaung-gaw or Zaung-gaw-kyaw-shouk.	Thai-gyi-oo-yaung.	Kyauk-pauk	Do.
na; Maing-na;	Do. .	Oo-baw-yē-shan.	Kabana .	Do.
...	Do. .	Do. .	Do. .	Ah-poo-chôke.
...	Zaung-gaw-kyaw-shouk or Zaung-gaw-oo-shouk.	Do. .	Do.	Do.
...	Do. .	Lay-bet-na .	Do. .	Do.
...	Do. .	None . .	Kala-na or Wun-kya-na.	Do.

OXEN

Burmese names for

District.	ORDINARY Foot and Mouth Disease.
(Burmese)	Sha-na-kwa-na
Pakokhu	Do.
Minbu	Do.
Magwé	Do.
Thayetmyo	Do.
Prome	Do.
Mandalay	Do.
Toungnoo	Do.
Tharrawaddy	Do.
Henzada	Do.
Meiktila	Sut-sut-na
Yaméthin	Do.
Akyab	Do.

Diseases of Cattle. (*G. H. Evans.*) AND BUFFALOES.

DISEASES:—(A) CONTAGIOUS.

Cow-pox.	Scabies	Influenza
Nwa-kyauk .	Wè . . .	Tôh Kway.
Do. . .	Do. . . .	Do.
Do. .	Do. . . .	Do.
Do. . .	Do. . . .	Do.
Do. . .	Do. . . .	Do.
Do. . .	Do. . . .	Do.
Do. .	Do. . . .	Do.
Do. .	Do. . . .	Do
Do. . .	Do. . . .	Do.
Do. . .	Do. . . .	Do.
Do. . .	Do. . . .	Do.
Do. . .	Do. . . .	Do.
Do. . .	Do. . . .	Do.

OXEN **Burmese names for**

ORDINARY DISEASES:—

(*a*) AFFECTING

(*b*) AFFECTING ALIMEN-

District.	Aptha.	Inflammation of Oesophagus.	Choking.
(Burmese) . .	Pa-zat-na .	Le-gyaung-yaung-gyin.	Asa-nin-gyin .
Pakokhu .	Do. .	Lai-do-na .	Do. .
Minbu . .	Do. .	Do. .	Do. .
Magwé . .	None . .	Do. .	Do. .
Thayetmyo .	None . .	Do. .	Do. .
Prome . .	None . .	Do. .	Do. .
Mandalay . .	Sha-na-gale .	Sôn-so-na .	Do. .
Tounghoo . .	Sha-poh-na .	Apoo-gyeik or Sôu Sona.	Do. .
Tharrawaddy .	Do. .	Do. .	Do. .
Henzada . .	Do. .	Do. .	Do. .
Meiktila . .	Do. .	Do. .	Do. .
Yaméthin . .	Do. .	Do. .	Do. .
Akyab . .	Do. .	Lai-yan-na .	Do. .

Diseases of Cattle (*G. H. Evans*) AND BUFFALOES.

(B) NON-CONTAGIOUS.

BONES—*Nil*.

TARY SYSTEM.

Vomition.	Colic.	Gastritis.	Hoven.	Impaction of Rumen.	Inflammation of 4th Stomach.
Au-an-gyin.	Wun-kike-gyin.	Wûn-yaung-gyin.	Wun-byi-wun-yaung.	Asa-aing kyat-gyin.	Sa-dote-ta-asa Aing-yaung-gyin.
Do.	Do.	None.	Wau-yaung.	Soung-dat-chouk-gyin.	None.
Do.	Do.	None.	Do.	None	None.
Do.	Do.	None.	Oo-baw-yè-shan.	None	None.
Do.	Do.	None.	Wun-baw-wun-yaung.	None	None.
Do.	Do.	None.	Do.	None	None.
Do.	Do.	None.	Do.	None	None.
Do.	Do.	Bein-byè-ko-yaung or Asein-yaung.	Do.	Asa-ma-kyai or Yin-bye-yin-kai.	None.
Do.	Do.	Thayet-ywet-gyi-gyin.	Do.	Do.	None.
Do.	Do.	Oo-poo-laung-gyin.	Do.	Do.	None.
Do.	Apoo-	Do.	Do.	Do.	None.
Do.	Wè-aye.	Do.	Do.	Do.	None.
Do.	Do.	Do.	Do.	Do.	None.

OXEN — Burmese names for

District.	(b) Affecting Alimentary — Constipation.	Diarrhœa.	Dysentery.
(Burmese)	Wun-choke-gyin	Wun-hya-gyin	Thway-thoon-wun-kya.
Pakokhu	Do.	Do.	Do.
Minbu	Do	Do.	Do
Magwé	Do.	Do.	Do.
Thayetmyo	Do.	Do.	Do.
Prome	Do.	Do.	Do.
Mandalay	Do.	Do.	Do.
Tounghoo	Do.	Do.	Do.
Tharrawaddy	Apoo-chôk	Do.	Do.
Henzada	Do.	Do	Do.
Meiktila	Do.	Do.	Do.
Yaméthin	Do.	Do.	Do.
Akyab	Do.	Do.	Do.

SYSTEM—*continued.*

Enteritis.	Ascites.	Calculi.	Hernia.	Indigestion.
Oo-yaung-gyin.	Yē-byin-na .	Kyauk-te-gyin	Moat-ta	Asa-ma-kyay-gyin.
None . .	Do. .	Do. .	Do. .	Do.
None . .	None . .	Do. .	Do. .	Do.
None . .	None . .	None . .	Do. .	Do.
None . .	None . .	Kyauk-te-gyin	Do. .	Do.
None . .	Yē-byin-na .	Do. .	Do. .	Do.
None . .	Do. .	Do. .	Do. .	Do.
Oo-yaung-gyin.	Byin-swè .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do. .	Do.
None . .	None . .	None . .	Do. .	Do.
None . .	None . .	None . .	Do. .	Do.

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Burmese names for

District.	(c) Affecting Liver.		(d) Affecting Spleen.	
	Congestion of Liver.	Jaundice.	Enlargement of Spleen.	Morbid Growths.
(Burmese) . .	Athè-nike-thway-soo-gyin.	Thè-gyay-na.	Tha-yet-ywet-kyi-gyin.	Akyaik-akai.
Pakokhu . .	None . .	None .	Do. .	Do. .
Minbu . .	None . .	None .	Do. .	Do. .
Magwé . .	None . .	None .	Do. .	Do. .
Thayetmyo .	None . .	None .	Do. .	Do. .
Prome . .	None . .	None	Do. .	Do. .
Mandalay . .	None . .	None .	Do. .	Do. .
Tounghoo . .	Athè-yaung-na.	Thè gyay-na.	Do. .	Do. .
Tharrawaddy .	Do. .	Do .	Do. .	Do. .
Henzada . .	Do. .	Do. .	Thayet-ywet-yaung.	Do. .
Meiktila . .	None . .	None .	None .	Do. .
Yaméthin . .	None . .	None .	Thayet-ywet-yaung.	Kyat-poo .
Akyab . .	None . .	None .	None .	None .

(*e*) Affecting Respiratory System.

Cough.	Catarrh.	Laryngitis.	Bronchitis.	Congestion of Lungs.	Asthma.	Pleurisy.
Chaung-soe-na.	Nha-see-na.	Le-myo-poo-laung-na.	Chaung-soe-na.	Asôk-poo-laung-na.	Pan-na .	Lay-ta-gyin-na.
Do. .	Do. .	Gyeik-hauk.	None .	None .	Thet-lou-kwè.	Do.
Do. .	Do. .	Do.	None .	None .	Do. .	None.
Do. .	Do. .	Do. .	None .	None .	Do. .	None.
Do. .	Do. .	Do. .	None .	None .	Do. .	None.
Do. .	Do. .	Do. .	None .	None .	Do. .	None.
Do. .	Do. .	Do. .	None .	None .	Do. .	None.
Do. .	Do. .	Apoo-môke.	Tan-na .	Asôk-poo-laung-na	Do. .	Lay-ta-gyin-na.
Oo-au-na.	Do. .	Do. .	Do .	Asôtè-na	Do. .	Lay-tah-na.
Do. .	Do. .	Do. .	Do. .	Do. .	Leight-na	Lay-an-na
Do. .	Do. .	Do. .	Choung-sae.	None .	Do. .	None.
Do. .	Do. .	Atwin-kyat.	Do. .	Lay-bet-na.	None .	None.
Do. .	Do. .	Le-myo-poo-gyin.	Do. .	None .	Leight-na	None.

OXEN — Burmese names for

(*f*) Affecting Heart and

District	(*g*) Affecting Nervous System.		
	Paralysis.	Epilepsy.	Apoplexy.
(Burmese)	Lay-gyaw-the-na	Tet-na	Wût-yoo-na
Pakokhu	Do.	Do.	Do.
Minbu	Do.	Do.	Do.
Magwé	Do.	Do.	Do.
Thayetmyo	Do.	Do.	Do.
Prome	Do.	Do.	None
Mandalay	Lay-byat-na	Do.	Wet-yoo-na
Tounghoo	Lay-pyat-na	Do.	Wet-yoo-na *or* Wut-na
Tharrawaddy	Do.	Do.	Do.
Henzada	Chenai	Do.	Do.
Meiktila	Do.	Do.	Do.
Yaméthin	Kalai-na	None	None
Akyab	Do.	Tet-na	Wet-yoo-na *or* Wut-na.

Diseases of Cattle. (*G. H. Evans.*) AND BUFFALOES.

CIRCULATORY SYSTEM :—*Nil.*

(*h*) AFFECTING EYE.			
Chorea.	Conjunctivitis Opthalmia	Worm in Eye.	Opacity of Cornea.
Akyaw-swè-na .	Myet-se-na .	Myet-pôh-na .	Tain-tha-la.
Do. .	Do. . .	Myet-poh-da-na	Do.
Do. .	Do. . .	Do. .	Do.
Do. .	Lait pya-soat .	Do. .	Do.
Do. .	Do. . .	Do. .	Do.
Do. .	Do. . .	Do. .	Do.
Do. .	Do. . .	Do. .	Do.
Do. .	Do. . .	Do.	Do.
Tone-na *or* Sun-na.	Do. . .	None . .	Do.
Tone-na . .	Do. . .	Myet-poh-swè .	Do.
None . .	Do. . .	Do. .	Do.
None . .	Do. . .	Do. .	Do.
Tone-na *or* Sun-na.	Do. .	Do.	Do.

OXEN — Burmese names for

(i) AFFECTING SKIN.

District	Warts.	Maggots.
(Burmese) . .	Kywet-nō . . .	Lauk . . .
Pakokku . .	Do. . . .	Poh-kya . . .
Minbu	Do. . . .	Do. . . .
Magwé . .	Do. . .	Do. . . .
Thayetmyo .	Do. . . .	Do. . . .
Prome . .	Do. . . .	Do. . . .
Mandalay . .	Do. . . .	Do. . . .
Toungoo . .	Do. *or* Noo-na .	Do. . . .
Tharrawaddy .	Ka-toot-na, *or* Ma-da-ma-na.	Do. . .
Henzada . .	Do. . . .	Do. . . .
Meiktila . .	Do. . . .	Do. . . .
Yaméthin . .	Do. . . .	Do. . . .
Akyab . .	Do. . . .	Do. . . .

Diseases of Cattle. (*G. H. Evans.*) AND BUFFALOES.

		(j) PARASITICAL.	
Ringworm.	Tumours.	Intestinal worms.	Pediculi.
Pway . .	Akyeik-akai .	Than-toh-na .	Thun.
Do. . .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do.
Do. . .	Do .	Do. .	Do.
Do. . .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do.
Do. . .	Do. .	Do. .	Do.
Do. . .	Kyat poo . .	Do. .	Do.
Do. . .	Do. .	Do. .	Do.

OXEN

Burmese names for

District.	(k) Affecting Generative		
	Metritis.	Parturient Fever.	Parturition.
(Burmese) . .	Tha-aing-yaung-na.	Me-yat . .	Mway-pwa-gyin
Pakokhu . .	Do. .	Do. . .	Do. .
Minbu . .	Do. .	Do. . .	Do. .
Magwé . .	Do. .	Do. . .	Do. .
Thayetmyo .	Do. .	Do. . .	Do. .
Prome . .	Do. .	Do. . .	Do. .
Mandalay . .	Do. .	Do. . .	Do. .
Tounghoo . .	Do. .	Me-yat-pein .	Do. .
Tharrawaddy .	Do. .	Do. .	Do. .
Henzada . .	Do. .	Do. .	Do. .
Meiktila . .	Do. .	Do. .	Do. .
Yaméthin . .	None . .	None . .	Do. .
Akyab . .	None . .	Me-yat-pein .	Do. .

Diseases of Cattle. (*G. H. Evans*) **AND BUFFALOES**

Organs.			(*l*) Fevers	
Mammitis	**Abortion**	**Orchitis**	**Rheumatic fever**	**Malarial fever**
Noh-ohn-yaung-na	Ko-wun-byet-na	Gway-yaung-na.	Doo-la .	Nget-pya.
Do.	Tha-shaw-gyin	Do	Do .	Do.
Do	Do .	Do. .	Do. .	Do
Do	Do .	Do .	Do .	Do.
Do	Do .	Do.	Do .	Do.
Do.	Do. .	Do	Do	Do.
Do .	Do. .	Do .	Do	Do.
Do.	Tha-pyet *or* Tha-shaw.	Do. .	Padayat-na	Do.
Do. .	Tha shaw .	Do. .	Doo-la .	Do.
Do. .	Do. .	Do. .	Do. .	Do.
Do. .	Do .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Lay-bet-na .	Do.
Do. .	Do. .	Do. .	Do. .	Do.

OXEN — Burmese names for

District.	(m) Affecting Urinary System: Nephritis.	Urethritis.	Rupture of Bladder.
(Burmese)	Kyaukkat-yaung-gyin.	Nyaung-na	Tha-aing-pauk-gyin.
Pakokhu	None	Do	None
Minbu	None	Do.	None
Magwé	None	Do.	None
Thayetmyo	None	Do.	None
Prome	None	Do.	None
Mandalay	None	Do.	None
Toungboo	Kha-kike-na	Ye-byin-na *or* ye-ne-na.	Tha-aing-pauk-gyin.
Tharrawaddy	Do.	Do.	Do.
Henzada	Do.	Do.	Do.
Meiktila	None	Do.	Do.
Yaméthin	None	None	None
Akyab	None	Ye-byin-na *or* ye-ne-na.	None

Diseases of Cattle. (*G. H. Evans.*) AND BUFFALOES.

(n) Affecting Locomotory System.			
Incontinence of urine.	Dislocation	Laminitis.	Abscess.
See-aung-gyin .	Asite-lwai-gyin .	Tôk-kine-myay-swè.	Ana-b at.
Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Mye-kine .	Do.
Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Ye-thà.
Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Kyat-na.
Do. .	Do. .	None . .	Do.
Do. .	Do. .	Mye-kine .	Do.

OXEN

Burmese names for

District.	(o) Miscellaneous.		
	Rheumatism	Anæmia.	Scrofula.
(Burmese) . .	Doo la .	Che-nai-gyin .	Kyat . .
Pakokhu . .	Do .	Do .	Do. . .
Minbu . .	Do .	Do. .	Do . .
Magwé . .	Do.	Do	Do. . .
Thayetmyo .	Do. . .	Do.	Do. .
Prome . .	Do. . .	Do. .	Do. . .
Mandalay . .	Do. .	Do. .	Do. . .
Tounghoo . .	Do. . .	Do. .	Do. . .
Tharrawaddy .	Do. . .	Do. .	Do. . .
Henzada . .	Do. . .	Do. .	Do. . .
Meiktila .	Le-bat-na .	Do. .	Do. . .
Yaméthin . .	Do. .	Do. .	Do. . .
Akyab . .	Do. .	Do. .	Do. . .

Diseases of Cattle. (G. H Evans) AND BUFFALOES.

Surgical Operation.	Wounds.			
Castration.	Punctured.	Incised.	Contused.	Lacerated.
Gway-thin-gyin.	Soo-nyaung-doh-na.	Dah-khot-na .	Atha-kyay-na	Tha-ye-soak pyat-na.
Sôn-wa-thin-koot.	Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Do.	Do.
Do. .	Do. .	Do. .	Do. .	Do
Do. .	Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do .	Do. .	Do.
Do. .	Do. .	Do .	Do .	Do
Thin-koot *or* Son-ma.	Do. .	Do. .	Do. .	Do
Do. .	Do. .	Do .	Do. .	Do.
Son-ma *or* Bhe-theni.	Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Do. .	Do.
Do. .	Do. .	Do. .	Do .	Do.

G I. C. P. O.—No. 66 R. & A.—24-9-96.—2,100.—W. B. G. O. 551-94.

(*Vegetable Product Series, No. 23.*)
(*Fibres.*)

THE

AGRICULTURAL LEDGER.

1896—No. 11.

CROTALARIA JUNCEA.

(SUNN-HEMP.)

[*Dictionary of Economic Products, Vol. II.,* C. 2105.]

SUNN-HEMP FIBRE.

Result of Examination in the Research Department, Imperial Institute, London.

Examination of Sunn-Hemp fibre from Burma.

On the 8th January 1896 2lb of the best quality of Sunn-Hemp fibre (Crotalaria juncea) produced in the Tavoy district, Burma, and received from the Revenue Secretary to the Chief Commissioner, Burma (letter No. 705—8 A.-8, dated 23rd July 1895), was sent to the Imperial Institute, London, for examination by experts. In the forwarding letter (R. E. P. No. 1/1 Flying Seal, dated 8th January 1896) it was asked that the report to be furnished on the fibre might include its value in the London market together with any remarks that could be given as to how the quality of the fibre might be improved. These requests were made at the instance of the Burma Administration.

The Secretary and Director, Imperial Institute, acknowledged receipt of the sample on the 13th February 1896 (Flying Seal Series No. 74), and stated that portions of it had been examined by practical experts of the Institute who reported as under:—

Mr. C. E. Collyer states that this hemp would sell freely on the London market, and he considers that its cultivation should be encouraged as much as possible. He states that the fibre is similar to that of the "Gopaulpur Hemp," being strong, bold and clear, of a somewhat dull colour, and from 36 to 40 inches in length. He fixes its value, as represented by the sample sent, at between £16-10-0 and £17-0-0 per ton, but adds that the fibre should be better cleaned than the sample is, and should also be brighter in colour; and that, if more carefully prepared, its value would be from £2 to £3 per ton higher than that above quoted.

Messrs Puddy & Co. confirmed by independent reference to them the statements of Mr. Collyer. They find the fibre to be of fair quality, and state that it might be brighter and longer with advantage; but that it is saleable on the London market, and that if they had at the present time a shipment on hand, they could secure £16 to £16-10-0 per ton for it.

Sir Frederick Abel further stated the fibre was being examined in detail by the comparative process adopted in the Research Department of the Institute, and that the results would follow.

CROTALARIA juncea.

Sunn-Hemp

These were duly received with Flying Seal letter No. 77, dated the 20th February 1896, together with results of the examination of a sample of Sunn-Hemp grown in Calcutta taken from the collection of fibres in the Indian Section of the Institute.

Results compared.

	Moisture.	Ash.	Loss by Hydrolysis. (*a*)	Loss by Hydrolysis. (*b*)	Loss by Mercerising.	Loss by Acid purification.	Gain by Nitration.	Cellulose.	Length of ultimate fibre.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	m. m.
LEGUMINOSÆ.									
Crotalaria juncea (Burma).	9·8	3·1	9·2	15·8	8·8	3·7	35	87·4 87·5	5- ·8
Crotalaria juncea (Calcutta).	9·4	·5	10·5	14	9·1	1·6	?	90·6 91·0	5- ·55

These results confirm the opinion expressed by the practical experts in regard to the good quality of this fibre.

With the Flying Seal Series letter, already quoted, were forwarded the results, given below, of an examination of two kinds of fibre from India which were among those specially referred to by Dr. Daniel Morris, C.M.G., of the Royal Gardens, Kew, in a course of lectures on fibres, which he recently delivered at the Society of Arts:—

Results of examination of two other fibres.

	Moisture.	Ash.	Loss by Hydrolysis. (*a*)	Loss by Hydrolysis. (*b*)	Loss by Mercerising.	Loss by Acid purification.	Gain by Nitration.	Cellulose.	Length of ultimate fibre.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	m. m.
MALVACEÆ.									
Hibiscus cannabinus (Saharanpur).	10·8	1·	12·2	19·1	18·3	2·7	40·	74·9	3- ·4
Urena lobata (Manbhoom).	9·9	2·4	12·2	16·3	15·7	3·0	25·8	73·5	2·2- 5

Sir Frederick Abel concludes by remarking that 'the **Hibiscus cannabinus**, which has, I believe, been proposed as a substitute for jute in some districts of India where the latter is not cultivated, is shown to be superior to jute of average quality. The measurements of length of fibre have been carefully made, and they agree with those obtained by Messrs. Cross and Bevan in the examination of a sample of fibre from the Colonial and Indian Exhibition. **Hibiscus cannabinus.**

The **Urena lobata** is also a fibre of the jute type, possessing very similar qualities to jute. The staple of the fibre is short, and the percentage of cellulose which it was found to contain is somewhat lower than that observed by Messrs. Cross and Bevan in their published analysis of a sample of the same description of fibre.' **Urena lobata.**

G. I. C. P. O.—No. 94 R. & A.—25-7-96.—2,100.—W. B. G.

(Veterinary Series, No. 20.)

THE

AGRICULTURAL LEDGER.

1896—No. 12.

OXEN.

[*Dictionary of Economic Products, Vol. V.*, O. 551-94.]

NELLORE CATTLE.

Report on Cattle met with at the Kotappa Konda Sevaratri Festival, 1896, by* MR. C. K. SUBBA RAO, *Sub-Assistant Director of Agriculture, Madras.

Castration. Reported influence on colour.

There were for sale only 11 young bulls of the Nellore breed born and bred in Guntur, Sattenapalli and Narasuroapet Taluks, aged two to four years and valued at R80 to R150. They were white, the forehead, neck and shoulders alone being somewhat grey. I was very much astonished to learn that even these grey patches turn pure white after the animals are castrated, a piece of information worth verifying by experiment. The number of cattle (as a rule only bulls) brought for sale during any year does not appear to exceed fifty. The measurements given below indicate the average size of the animals :—

Length of the body from the horn to the root of the tail, 66 inches.
Height at the withers (excluding the hump), 54 inches.
Length of the fore legs from the elbows downwards, 2½ feet.
Length of the face, 18 inches.
Breadth of the face between the eyes, 6 to 7 inches.
Breadth of the muzzle, 3 to 4 inches.
Girth of the chest immediately behind the fore legs, 69 inches.
Length of the neck, 22 inches.
Length of the horns, 4 inches.
Girth of horns at the base, 4½ inches.

Stated to affect growth of the animal.

The owners said that the animals, when calves, had all the milk of their dams; that the bulls are castrated as a rule when four years old; that the animals fetch much smaller prices after castration than before; that the development of the chest is arrested, and that of the loins promoted, by castration. The bulls were born of what are called Ambota Kodalu, and in the ceded districts Venkatamlu Koda. These are bulls set at large after being branded with the mark of a trident on the 11th day after a man's decease, as well as those dedicated to temples according to vows. These bulls are fed by the people and are allowed to trespass on fields with impunity for the purpose of grazing. The hind

OXEN.	Nellore Cattle.

quarters were rather mean in the majority of the bulls brought for sale. To estimate the total number of yoked bullocks brought for the festival at 30,000 is rather under the mark. Besides many of the cart-bullocks a few thousand cows, buffaloes, heifers, etc., are brought according to vows, for making *Pradakshina* (circumambulation) round the hill. The Agricultural Inspector and I inspected as many as possible of the cart-bullocks with a view to discover what different breeds there were among them. Cattle of what is called the *Desavale* (indigenous) or mixed breed were found to constitute the greatest number. In shape and size animals of this group presented an endless variety so that it was impossible to classify them. A good number of carts came from Addanki, Dursi, Podili and Kandakur, the cattle belonging to the Nellore breed, and so also many from the upland taluks of the Kistna District. Of course most of these were castrated, being used for carting purposes. I saw among them specimens of what the young bulls brought for sale would develop into after castration and completing their growth. They were comparatively very massive creatures with a very heavy face, and white all over the body, without grey patches on the forehead, neck and shoulders as in young bulls. The measurements given below indicate their average size :—

Desavale (Indigenous) or mixed breed.

Length from the horn to the root of tail, 84 inches.
Girth of the chest, 84 inches.
Height at the withers, 60 inches.
Length of the fore legs from the elbows downwards, 33 inches.
Breadth of the forehead between the horns as well as that between the eyes, 10 inches.
Breadth of the muzzle, 4 inches.
Length of the face, 24 inches.
Length of the horns, 15 inches.

Dachapalli Cattle. Description.

The cattle that come from Dachapalli and other parts of Palnad Taluk bordering on the Kistna are called *Paramata* (western) or *Palnad Seema Gittalu*, in contradistinction from those of the other upland taluks which seem to be called *Kondavidu Seema gittalu.* They are comparatively small with longer horns which are either divergent or, as is more often the case, have their ends pointing towards each other. They are said to be comparatively hardy with short legs. The prevailing colour is dirty white. They are as a rule castrated one or two years later than those of the Nellore breed of the other upland taluks. The muzzle is finer than that of the Nellore breed. The dewlap is not so pendulous, nor the hump so large. The hoofs are comparatively strong. The measurements given below indicated their average size :—

Length of the body from the horns to the root of the tail, 57 inches.
Height at the withers, 48 inches.
Length of the front legs from the elbows downwards, 27 inches.
Breadth between the horns, 6 inches.
Breadth between the eyes, 7 inches.
Girth of the chest, 57 inches.
Length of the neck, 17 inches.

Dupud breed.

There were only a few specimens of the Dupud breed. I saw a fine pair yoked to a tahsildar's cart. In size, shape and temper they somewhat resemble the Mysore breed. Their horns are long, little divergent, and almost parallel and straight. They are swift trotters. The following measurements were taken with much difficulty, as the animals were ferocious :—

Length of the body from the horns to the root of the tail, 66 inches.
Height of the withers, 48 inches.
Length of the front legs from the elbows downwards, 27 inches.
Girth of the chest, 60 inches.

Nellore Cattle. (*C. K. Subba Rao.*) **OXEN.**

Breadth between the eyes, 10 inches.
Breadth of the muzzle, 3 inches.
Length of the face, 21 inches.
Length of the horns, 18 inches.

Cattle of this breed are very hardy and their hoofs strong. As breeders of the Dupud cattle did not come to Kotappa Konda, further information regarding them was not available.

Bezwada and other cattle.

The cattle that came from Bezwada and Nandigama Taluks and the parts of the Nizam's dominions in the neighbourhood of those taluks differed from those of the upland taluks in having somewhat shorter legs. They are said to be better suited for draught purposes than those of the upland taluks which are better adapted for tillages.

The cows, heifers, etc., which were brought simply for making *Pradakshina* round the hill were all poor specimens of the Desavali breed.

O. 551-94.

G. I. C. P. O.—No. 19 R. & A.—25-7-96.—W. B. G.—2,100.

(Veterinary Series, No. 21.)

THE AGRICULTURAL LEDGER.

1896—No. 13.

OXEN.

[*Dictionary of Economic Products, Vol. V.,* O. 551—94.]

Review of Correspondence on the subject of Contributions to the Veterinary Series of 'The Agricultural Ledger.'

Towards the end of last year (1895), the Editor received a letter on the subject treated of in the Agricultural Ledger No. 6 of 1895, *viz.*, Management of Dairy Cattle in India. In that letter it was suggested that the collecting and publishing in the Ledger of notes supplementary to those already issued would be attended by useful results. The writer further indicated the various points on which it might be deemed desirable to collect information.

The Editor gladly availed himself of this voluntary offer to assist in providing information, and in referring the matter to the Civil Veterinary Department, stated that if the proposal were accepted he would be glad to publish its reply in the Agricultural Ledger.

In his letter No. 426 M., dated the 7th March 1896, the Assistant to Inspector-General, Civil Veterinary Department, welcomed the suggestion on the one condition that the notes so contributed must be the outcome of practical experience. He adds that most of the subjects on which it is proposed to contribute notes have been dealt with fairly exhaustively by professional workers and others in various parts of the world, yet, doubtless, notes on the different subjects indicated written in a simple manner would be welcomed by those who have charge of dairies and cattle. The writer goes on to say that in his opinion experiments in any direction connected with cattle should be made known for general information. Trials of indigenous drugs are especially interesting and valuable, and the Assistant Inspector-General cordially offers any assistance he can give, and concludes by suggesting that all who are interested in Cattle and Cattle Disease be invited to contribute an account of their experiences.

The Editor of the Agricultural Ledger will, therefore, be glad to receive notes of the nature indicated by the Assistant Inspector-General, Civil Veterinary Department, on any of the subjects (or other kindred ones) alluded to in the letter first above mentioned, which are as follows:—

(1) How to identify the age of the cow and number of parturitions.

OXEN.	Review of Correspondence, etc.

(2) Medicine for producing heat or œstrum in barren heifers or cows.
(3) Medicine for expulsion of after-birth if retained.
(4) Symptoms and treatment, etc., of Cattle Disease.

The Editor will also gladly examine and, where possible, identify the indigenous drugs sent to him, but would remind persons desirous of contributing in this commendable work that they should follow, as far as possible, the rules for the collection of specimens laid down in *The Agricultural Ledger No. 4 of 1894*

Notes, reports or suggestions as received will be transmitted to the Civil Veterinary Department, and when of sufficient merit will be published in the Ledger. When thought desirable arrangements will be made to have the efficacy of the drugs, that may be recommended for trial by correspondents, put to careful therapeutic test.

All interested in Dairy Farming or in the rearing of Cattle are cordially invited to contribute

O. 551—94.

G. I. C. P. O.—No. 95 R. & A. D.—13-7-96.—2,100.

(Vegetable Product Series, No. 24.)

THE

AGRICULTURAL LEDGER.

1896—No. 14.

PINUS EXCELSA.

[*Dictionary of Economic Products, Vol. VI., Pt. I.,* P. 737.]

PINUS GERARDIANA.

[*Dictionary of Economic Products, Vol. VI., Pt. I.,* P. 746.]

PINUS KHASYA.

[*Dictionary of Economic Products, Vol. VI., Pt. I.,* P. 757.]

PINUS LONGIFOLIA.

[*Dictionary of Economic Products, Vol. VI., Pt. I.,* P. 760.]

PINUS MERKUSII.

[*Dictionary of Economic Products, Vol. I., Pt. VI.,* P. 771.]

INDIAN TURPENTINES.

Results of the Examination of Indian Turpentines in the Research Department of the Imperial Institute by* PROFESSOR H. E. ARMSTRONG, F.R.S. *Also a Review of the Correspondence relating to Collection of the Specimens by the Reporter on Economic Products.

In the *Imperial Institute Hand-book No. 7* on RESIN AND TURPENTINE FROM INDIAN PINES, mention is made (pp. 21-23) of a sample of turpentine derived from either **Pinus khasya** or **Pinus Merkusii** that had been sent in 1881 to Professor Armstrong for examination. It was found to be an article "of the highest quality, equal to the best French" and "would form a most valuable article of commerce." On the Hand-book being published Professor Armstrong addressed a letter to Sir Frederick Abel, in which he pointed out the desirability of thoroughly studying all the Indian turpentines, and offered to undertake the task if furnished with 3 cwts. of the freshly collected crude exudation from each kind of tree. With letter 30th May 1894.

P. 736-773.

PINUS. | **Indian Turpentines.**

2nd June 1894. No. 23 F. S., dated the 2nd June 1894, **Sir F. Abel** forwarded the Professor's letter to the Government of India, and recommended acceptance of the gratuitous offer. He further stated that in the Imperial Institute sample store he had small quantities of the crude turpentine from **Pinus khasya** and **P. longifolia**, but none from **P. excelsa** or **P. Merkusii.**

21st Aug. 1894. After consultation with the Departments concerned a reply to **Sir F. Abel** was sent by the Government of India (letter No. 12 F. S., dated the 21st August 1894) which promised to provide **Professor Armstrong** with 3 cwts. each of the turpentines of **P. excelsa, P. khasya, P. longifolia** and **P. Merkusii**, and 5lb each of the other turpentines. **Sir F. Abel** acknowledged that letter in

28th Sept. 1894. No. 34 F. S., dated the 28th September 1894, in which he expressed his satisfaction of the promise to send large quantities of the four principal turpentines named. With regard to others he pointed out the necessity "to bear in mind the importance of a knowledge as to the resources, generally, of India in regard to this particular product, inasmuch as it is not improbable that new and important applications for turpentine may arise," for it is just "conceivable that India-rubber may be artificially manufactured in the future from turpentine, and in that case, the resources of India as regards this particular liquid may assume considerably increased importance."

25th Jan. 1895. The Inspector General of Forests on the 25th January 1895 addressed his letter No. 45 to the Conservator of Forests, School Circle, North-West Provinces, in which he called upon him to supply 3 cwts. of the crude exudation of **Pinus excelsa** and **P. longifolia**, as well as one gallon each of the oil.* His No. 46 to the Conservator of Forests, Eastern Circle, Upper Burma, asked for the turpentines but not the oils of **P. khasya** and **P. Merkusii.**

N.-W. P. and OUDH. 4th Feb. 1895. North-West Provinces and Oudh.—Reply was made to Inspector General of Forests, by the Conservator of Forests, School Circle (letter No. 92, dated 4th February 1895) to the effect that as he had no separate specimens of the resins and turpentines required he could not fully comply with the requisition until after the winter. He promised then to obtain special specimens from the Jaunsar Division.

20th Feb. 1895. Inspector General of Forests wrote (letter No. 173, dated 20th February 1895) in reply to Reporter on Economic Products (letter No. 1117—XVI-43, dated 12th February 1895), that the only other Indian species of **Pinus** besides **Pinus excelsa, P. khasya, P. longifolia,** and **P. Merkusii** is understood to be **P. Gerardiana.**

BURMA. 11th Feb. 1895. *Pinus khasya.* Burma.—The Conservator of Forests, Eastern Circle, replied to Inspector General of Forests (letter No. 112 C. R., dated 11th February 1895) that he had arranged for the collection of 3 cwts. of **Pinus khasya** resin in the Southern Shan States, but that **Pinus Merkusii**, so far as known, does not occur in the Eastern Circle, and therefore no collection of that resin can be made. The Conservator added: 'In 1892, with the sanction of the Chief Commissioner, I

* Extracted from the above species by means of steam distillation.

BURMA.

Pinus khasya.

ordered some experimental tapping of **Pinus khasya** to be made in the State of Thamakhan and at Bernardmyo in the Ruby Mines District. The experiment at Thamakhan was carried out by **Mr. Jackson**, Deputy Conservator of Forests, who in January 1894 made 415 tappings on 275 trees, of over 4 feet 6 inches in circumference, in the Kalaw forests. The tappings were made in the manner described on page 14 of Handbook No. 7 of the Imperial Institute Series, but the wounds were made deeper and broader. The outturn of crude turpentine was as follows:—

January	20 days	27½	viss.
February		43¼	"
March		84½	"
April		131	"
May		43	"
June		45	"
		374¼	viss (1,365℔).

The experiment was not carried out further. The cost of collection was as follows:—

	R	a.	p.
Pay of coolies	212	0	0
Purchase of pots, tools, etc.	57	6	0
Cart hire to railway	27	0	0
TOTAL	296	6	0

Conf. Appendix A.

The turpentine was made over to **Messrs. Finlay, Fleming & Co.**, of Rangoon, who have undertaken to sell it for us in England. Owing to changes of officers and other reasons, the experiment in the Ruby Mines, where the forests are of small extent and very scattered, was not carried out in a satisfactory manner. Ten trees were tapped on the 21st May 1894, and more trees were tapped at intervals up to the end of August, by which time 56 trees in all had been tapped and 25℔ of resin collected.

INSPECTOR GENERAL OF FORESTS on submitting the foregoing letter stated that the Conservator of Forests, TENASSERIM CIRCLE, had been asked to supply 3 cwts. of the crude exudation from **Pinus Merkusii**.

Pinus khasya. Registered No. 6351. 3rd June 1895.

BURMA.—The Conservator of Forests, EASTERN CIRCLE, wrote on 3rd June 1895 (letter No. 444—28A-3) advising despatch of about 3 cwts. of crude turpentine from **Pinus khasya** collected at Kalaw in the Southern Shan States. Acknowledged by letter No. 1175—42, dated the 5th September 1895. Despatched to Imperial Institute on 16th August 1895.

Pinus Merkusii.

In his letter to the Inspector General of Forests, the Conservator corrected his previous statement as to **Pinus Merkusii** not being found in his Circle, in so far that the tree is met with in the Salween drainage but not within any reasonable distance of the Mandalay-Rangoon Railway.

PINUS.	Indian Turpentines.

BURMA. 17th June 1895.

The Deputy Conservator of Forests, SALWEEN ATARAN DIVISION, Moulmein, advised, in his letter No. 6—58, dated 17th June 1895, the despatch of about 70 viss of the resin of **Pinus Merkusii.** Acknowledged by letter No. 1176—42, dated the 5th September 1895. Despatched to Imperial Institute through Agent for Government Consignments on 16th August 1895.

Pinus Merkusii. Register No. 6322. 7th June 1895.

With his endorsement to Inspector General of Forests, No. 390—74, dated 7th June 1895, the Officiating Conservator of Forests, TENASSERIM CIRCLE, forwarded the following particulars of cost of collecting 70 viss (245lb) of the resin of **Pinus Merkusii** in the SALWEEN ATARAN DIVISION :—

	R	a.	p.
Collection of 70 viss at R35 °/$_o$ viss	24	8	0
Elephant hire for carriage of ditto	4	0	0
Bullocks	4	0	0
Cart	2	0	0
Freight by launch	0	14	0
Coolie hire	0	8	0
Purchase of 7 empty tins at annas 4	1	12	0
TOTAL	37	10	0

27th June 1895.

PANJAB.—The Inspector General of Forests in his letter No. 613, dated the 27th June 1895, stated that the Conservator of Forests, Panjab, had been asked to supply 10lb of the crude exudation from **Pinus Gerardiana.**

Pinus Gerardiana.

10th July 1895.

Pinus khasya.

BURMA.—The Conservator of Forests, EASTERN CIRCLE, wrote letter No. 171 C. R., dated 10th July 1895, with regard to the 3 cwts. of crude turpentine from **Pinus khasya** collected by him, that this was obtained from trees growing in the forests near Kalaw adjacent to the western edge of the Shan plateau at an elevation of about 4,500 feet in Latitude 20° 40′ and Longitude 96° 35′. The collection lasted from the 15th February to the 31st May 1895, and the tapping was carried out in the manner described on page 14 of Hand-book No. 7 of the Imperial Institute Series, except that the wounds in the tree were much deeper and broader. The cost of collection, excluding railway freight, amounted to R143. The Conservator was unable to give any details as to the number of trees tapped or the yield of each tree but repeated the information given in his letter (No. 112 C. R., dated 11th February 1895), regarding the experimental tapping of **Pinus khasya** conducted in the State of Thamakan during 1894.

The Conservator further stated that specimens of leaves and cones were being collected and would be duly forwarded.

IMPERIAL INSTITUTE. 8th Aug. 1895.

IMPERIAL INSTITUTE.—The Reporter on Economic Products wrote on the 8th August 1895 (No. 16 F. S.) with reference to the Imperial Institute letter No. 44 F. S., dated the 8th May, and reported that satisfactory progress had been made, although the process of securing such large samples as those required by the Institute was necessarily slow. Of **Pinus khasya** 3 cwts. of the crude turpentine had been received along with 245lb of that of **Pinus Merkusii.** These were shortly to be despatched to the Institute. With regard to the crude

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IMPERIAL INSTITUTE.

turpentine from **Pinus longifolia** and **Pinus excelsa**, which had been asked for from the North West Provinces, it was believed that these would shortly arrive. The letter concluded by stating that some considerable difficulty had been experienced in discovering the other trees that might be expected to afford products of the nature here dealt with. **Pinus Gerardiana** had been mentioned, and arrangements had been made to procure 10lb. of the resin from that tree.

BURMA. Pinus khasya. *19th Aug. 1895.*

BURMA.—By his letter No. 1162, dated the 19th August 1895, the Conservator of Forests, EASTERN CIRCLE, advised the despatch of specimens of the leaves and cones of the trees from which the **Pinus khasya** turpentine was collected. Acknowledged by letter No. 1252—42, dated the 20th September 1895.

Pinus Merkusii. *23rd Nov. 1895.*

By letter No. 1622—42, dated 23rd November 1895, the Conservator of Forests, TENASSERIM CIRCLE, was asked to supply leaves and cones of the tree from which the crude **Pinus Merkusii** turpentine was collected as well as information required by the Imperial Institute authorities on the following points:—(1) Locality where crude turpentine was extracted, its latitude and longitude; (2) elevation; (3) number of trees tapped and number of incisions made to produce the 70 viss of turpentine; (4) months when tapped and the yield in each month; (5) average yield of each tree.

IMPERIAL INSTITUTE. *25th Nov. 1895.*

Register No. 6322. No. 6351.

IMPERIAL INSTITUTE.—Letter was sent on 25th November 1895 (Flying Seal Series No. 30) advising the despatch through the Agent for Government Consignments, Calcutta, on the 16th August 1895, of three cases (Nos. 61, 62, 63) containing about 220lb of the crude turpentine of **Pinus Merkusii**, and one cask (No. 64) containing about 3 cwts. of the crude turpentine of **Pinus khasya.** In the same letter was advised the despatch by post of the cones and leaves of **Pinus khasya,** together with the information furnished by the Conservator of Forests, EASTERN CIRCLE, regarding place of collection, etc., of the crude turpentine from **Pinus khasya.** The letter further stated that no information regarding the conditions under which the crude turpentine from **Pinus Merkusii** was collected had reached the Reporter's office.

PANJAB. *8th Dec. 1895.*

Pinus Gerardiana. Register No. 6685.

PANJAB.—By endorsement No. 592, dated 8th December 1895, the Deputy Conservator of Forests forwarded copy of letter No. 32 R., dated 10th August 1895, from Forester Rattan Chand together with 12lb of crude exudation from **Pinus Gerardiana,** also specimens of leaves and cones, and stated that on the 29th and 30th July about 50 trees were tapped on the Spanish system in the Tangling Forest Compartment No. 38 A. between the Shaengarang and Telga Dhar, Kailas Range, Bashahr State, SIMLA DISTRICT. The trees stood on a north-western aspect where the soil was generally rocky and steep with an elevation of about 7,800 feet. At the time of collection the weather was cloudy and rainy, and not favourable for the free exudation of resin owing to which the resin collected on the 4th and 9th instant barely amounted to 12lb. Despatched to Imperial Institute on 14th February 1896 in Boxes Nos. 102 and 105, Invoice No. 15.

PINUS. **Indian Turpentines.**

N.-W. P. and OUDH. 21st Dec. 1895. Pinus excelsa. Register No. 6798. Pinus longifolia. Register No. 6798.

NORTH-WEST PROVINCES AND OUDH.—The Conservator of Forests, SCHOOL CIRCLE (letter No. 940, dated the $\frac{17th}{21st}$ December 1895) forwarded eight boxes, each containing two tins of resin, four of *kail* **(Pinus excelsa)** resin and the other four *chir* **(Pinus longifolia)** resin. The consignment was accompanied by leaves and cones of the respective trees from which the resin was collected. The letter stated that the resin was gathered at the Bagur and other blocks in the neighbourhood of the Kathain forests of the JAUNSAR DIVISION of the SCHOOL CIRCLE and in the Jaunsar Bawar *pargana* of the Dehra Dun District. The Conservator promised to forward the turpentine, which had to be specially manufactured, in the course of a few days.

Register No 6955. Register No. 6956. 11th Jan. 1896. 19th Dec. 1895.

NORTH-WEST PROVINCES AND OUDH.—The Conservator of Forests, SCHOOL CIRCLE, forwarded with his letter No. 1054, dated the 11th January 1896, two tins of turpentine distilled respectively from *kail* **(Pinus excelsa)** and *chir* **(Pinus longifolia).**

IMPERIAL INSTITUTE.—By letter No. 67 F. S., dated the 19th December 1895, the Institute acknowledged letter of the 28th November 1895, and stated that the information regarding crude turpentine of **Pinus khasya** had been forwarded to **Professor Armstrong.**

BURMA. 11th March 1896. Pinus Merkusii.

BURMA.—The Deputy Conservator of Forests, SALWEEN ATARAN DIVISION (letter No. 6—502, dated the 11th March 1896), communicated the following information regarding the crude turpentine collected from **Pinus Merkusii**:—

(*i*) The crude turpentine was extracted from the Megala Reserve and Forests around, which are situated in the Thoungyin Valley approximately in Latitude 16° 31′ N. and Longitude 98° 40′ E.

(*ii*) The hills on which the **Pinus Merkusii** is found range from 300 to 2,000 feet in height.

(*iii*) The Forest Ranger states that about 70 to 80 trees were tapped, one incision being made in each tree. He also states some 15 trees had two incisions made in them.

(*iv*) The crude turpentine despatched was tapped in April and May just before the heavy rains began. Rain had fallen and was falling which rendered collection difficult in the end. It is reported that the best months for collection are January, February and March.

(*v*) It is estimated that each tree may yearly produce some 3½ viss (= about 12lb) of crude turpentine.

The Deputy Conservator concluded by stating that the leaves and cones asked for would be forwarded as soon as these were collected and brought in.

9th April 1896.

The Deputy Conservator of Forests, THOUNGYIN DIVISION, **Mr. Blackwell**, who had previously supplied the crude turpentine from **Pinus Merkusii** advised despatch in his letter No. 21—21, dated the 9th April 1896, of leaves and fruit of **Pinus Merkusii.**

Professor Armstrong's Preliminary Report.

IMPERIAL INSTITUTE. 28th Feb. 1896.

IMPERIAL INSTITUTE.—By letter No. 78 F. S., dated the 28th February 1896, Sir Frederick Abel forwarded the following preliminary report containing the results of the examination by Professor H. E. Armstrong, F.R.S., of Turpentines from **Pinus khasya** and **Pinus Merkusii** supplies of which were furnished to him some time ago:—

Pinus khasya and Pinus Merkusii.

The crude turpentine from **Pinus khasya**, which was a grey, thick, pasty mass, containing a quantity of small pieces of wood, furnished by distillation with steam about 13/100 of its weight of oil; while the product from **Pinus Merkusii**, which was more fluid and clearer in appearance than the other, yielded nearly 19/100 of oil by corresponding treatment.

On a former occasion Professor Armstrong obtained from a sample of **P. khasya** 17 per cent. of oil, and he believes, therefore, that the particular sample now operated upon was collected under less favourable conditions, and that some of the oil had been lost by evaporation before the supply reached him.

The original turpentine and the distilled oil in each case have a very slight but agreeable odour, less pronounced in character than that of French Turpentine, but distinctly characteristic. In this respect the oils from the two turpentines were very similar. Professor Armstrong has satisfied himself of the identity of the oil from **Pinus khasya** with that which he examined several years ago, and which is referred to in pages 20 and 21 of Hand-book No. 7.

Considerable difficulties attend the determination of the precise chemical composition of oils of this class, and methods with this object in view are, at the present time, in course of elaboration Such experiments as Professor Armstrong has been able to make, have satisfied him that the oil of **Pinus khasya** is strictly comparable with French oil of Turpentine. This conclusion corresponds with that which he arrived at several years ago, as stated in the Hand-book. In this respect the oil from **Pinus Merkusii** closely resembles that of **Pinus khasya**.

Both oils distil within a very narrow range of temperature, near to 155°C., as does the furnished oil of turpentine; but the oil from **Pinus khasya** appears to contain a somewhat larger proportion than the others of a constituent of higher boiling point.

The two oils are very nearly alike in relative density, *viz.*:—

	Pinus khasya.	Pinus Merkusii.
At 20°C. . .	·8627	·8610

They both turn the ray of polarised light to the right, the so-called specific rotatory power being:—

Pinus khasya.	Pinus Merkusii.
36°·28	31°·45

A similar result was furnished by the oil from the sample of **Pinus khasya** formerly examined. The rotatory power of French turpentine is practically always about 36°.

The difference between the oils from the two Burmese turpentines is not of a kind to be of any practical importance. They are essentially similar, the slight difference between them being due to the presence in one or other of a small quantity of some substance in addition to the

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chief constituent. Practically they correspond exactly in properties to French oil of turpentine. Professor Armstrong is disposed to think that the oil of **Pinus Merkusii** may be more uniform than that from the other turpentine. He proposes to continue his experiments with these products for the purpose of endeavouring to determine their precise composition. Meanwhile, he states that both oils are of the highest quality, and that, in his opinion, they will be found to serve every purpose for which oil of turpentine (French or American) is used. They compare favourably even with the French oil, which is the highest quality in the market.

The resin or colophony which is left after distilling off the oil from the two samples is of good quality, and would be available for all purposes for which ordinary resin is used.

There appears to be no reason why India should not obtain whatever turpentine is required in the country from native sources. Professor Armstrong hopes, later on, to furnish a more detailed report in regard to the composition of the oils obtained from these two turpentines.

BURMA.

APPENDIX A.

BURMA.

Endorsement by the Conservator of Forests, EASTERN CIRCLE, *Upper Burma, —No. 200—36A-2, dated Mandalay, the 21st April 1896.*

21st April 1896.

Copy of the following forwarded to the Inspector General of Forests Calcutta, for information, in continuation of this office letter No. 2630—47 J., dated the 11th February 1895:—

Endorsement from the Conservator of Forests, PEGU CIRCLE, *to the Conservator of Forests,* EASTERN CIRCLE, *Upper Burma,—No. 2643—41-27, dated the 21st March 1896.*

Copy of Messrs. Finlay, Fleming & Co.'s report, dated 20th instant, on crude turpentine of **Pinus khasya** is herewith forwarded to Conservator of Forests, Eastern Circle, for information in continuation of this office No. 2544, dated 9th instant. A copy of No. 2642—41-27 of to-day's date to address of that firm is also annexed with a view to further communications on this subject being made direct and without the intervention of this office.

Letter from MESSRS. FINLAY, FLEMING & CO., *Rangoon, to the Conservator of Forests,* PEGU CIRCLE,—*dated the 20th March 1896.*

20th March 1896.

We have the honour to acknowledge receipt of your letter, No. 2544—41-27, dated the 9th instant, with reference to the 30 tins of crude turpentine made over to us in September 1894 We were under the impression that we had passed on to you the reports which our London firm obtained upon this turpentine, and now apologize for having omitted to do so.

The following is from Mr. Roverton Redwood, one of the highest chemical authorities of the day:—

DARK-COLOURED SAMPLE.

Physical Characters.—Semi-fluid of grey colour, and having the usual odour of crude turpentine.

Results obtained on Distillation.—On being distilled in a current of steam the sample yielded 29 per cent. of oil of turpentine leaving a residue of dark red resin. The oil of turpentine had a specific gravity of ·866 at 60° F. and a flashing point of 95° F. (close test).

LIGHT-COLOURED SAMPLE.

Physical Characters.—(Fluid somewhat viscid) nearly white in colour and with the usual odour of crude turpentine.

Results obtained on Distillation.—On being distilled in a current of steam the sample yielded 25 per cent. of oil of turpentine, leaving a residue of amber-coloured resin.

The oil of turpentine had a specific gravity of ·868 at 60° F. and a flashing point of 95° F. (close test).

Results of further Examination.—A sample of the oil of turpentine obtained by distillation in a current of steam was found to have a boiling

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point ranging from 310° to 360° F. and a specific rotatory power + 32° 36'.

General Remarks.—Even the darker of the two samples yields oil of turpentine of good merchantable colour and odour, and the lighter sample gives a good resin. The yield of oil of turpentine from both samples is satisfactory both as regards quantity and quality. The oil of turpentine possesses the same characters as the product manufactured in the United States having a dextro-rotatory action on a ray of plane polarised light and having a normal density and boiling point.

Judging from these results the oil of turpentine ought to answer all the purposes to which the American product is applied, but I would suggest that in the first instance a few barrels of it should be distilled, and a practical trial of it made by converting it into varnishes.

The following is from a London firm of Brokers :—

"If imported to this country in the crude state, the stills would have to be erected in an isolated position so as to avoid the risk of fire. To obtain the refined spirits of good colour the stills would have to be of copper. One of the principal distillers of Resin here values your crude turpentine at £4 to £6 per ton, and if he could obtain a constant supply at about this price he would be willing to go to the expense of erecting plant to work it. This price is based on the present value of American Refined Spirits of Turpentine at £22 per ton. We may mention that during the last few years the price of this article has varied between £20 and £28 in London, and as the market has been growing of late we should consider £24 the highest figure that can be reasonably expected for some time to come. The value of the resin obtained from your crude turpentine would be from £5 to £6 per ton in London.'

The following is from a large firm of varnish manufacturers :—

"We have carefully tested the two samples of Indian turpentine with the following results :—

	Dark quality.	Light quality.
Water	18·7	13·0
Spirit	21·3	24·5
Resin	60·0	62·5
	100·0	100·0

The spirit appears to be about equal to Russian Turps and Resin about F. Grade. To work it would necessitate a special plant being laid down, our resin stills not being suitable. We are willing to entertain the matter if we are guaranteed a certain supply per annum at a price not exceeding £4-10-0 per ton on our works."

It is evident from these reports that the Turpentine is of good quality, but at the prices named we fear it would not be possible to ship it at a profit to the London market.

It would certainly be out of the question to ship it in its crude form to sell at £4-10-0 per ton—a price which would do little more than cover cost of packing and freight.

Taking the quotations given for the refined products, *viz.*, £24 per ton for Spirits of Turpentine and, say, £5-10-0 for Resin and allowing, say, 15 per cent. for moisture, the return would be about £9-6-0 per ton to cover first cost, cost of refining, freight to London and sale expenses.

Do you think it worth while, and will you give us an idea of the probable quantity? We shall be glad to ascertain from our London friends the cost of refining plant.

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21st March 1896.

Copy of letter No. 2642—41-27, dated Camp, the 21st March 1896, from the Conservator of Forests, PEGU CIRCLE, *to* MESSRS. FINLAY, FLEMING & Co., *Rangoon.*

In thanking you for your letter of 20th instant, forwarding copies of reports on the crude turpentine from **Pinus khasya**, I have the honour to inform you that the attention of the Conservator of Forests, EASTERN CIRCLE, Upper Burma, has been drawn to the concluding portion of your letter, and that he has been invited to communicate direct with you as the specimens reported on were originally supplied by him.

APPENDIX B.

Forest Department Reports, North-West Provinces, for year ending 30th June 1894, pages 78 and 79, paragraphs 60 to 64.

60. *Resin.*—In the Jaunsár Division the tapping of pines for resin continued. No new trees were operated on, but about 3,900 trees previously worked were again tapped. 639 maunds of resin were collected at a cost of R1,168. The cost of collection was about R1-13-3 per maund against R1-8-0 in the previous year, owing to the flow of resin from trees previously tapped being less copious than from those tapped for the first time and to a greater amount of labour required in collecting a given weight of resin. The following shows the cost of resin operations during the year :—

	R
Collection of 639 maunds of crude resin . .	1,168
Price of boxes, tins, earthen pots, etc. . .	769
Carriage of 624 maunds of crude resin to Dehra .	808
TOTAL .	2,745

61. *Turpentine and Colophony.*—431 maunds of crude resin were distilled in Dehra, giving 278 maunds of rosin and 44 maunds or 409 gallons of turpentine. A market has now been established for the above products; the North-West Soap Company, Meerut, taking up all the rosin manufactured; and the North-Western Railway, the local Military Works Department, the Medical Department to some extent, the Mussoorie Brewery, and a few other regular customers the turpentine we can supply.

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The Conservator has put together the actual results of four years' working of the resin operations in the following table:—

PARTICULARS.	1890-91.	1891-92.	1892-93	1893-94.	TOTAL.
Number of maunds of crude resin collected . . .	201½	299½	623¼	639	1,763¼
Number of maunds of crude resin sold locally . .	22	200	3¼	15	240¼
Number of maunds of crude resin sent to Dehra . .	191	328	639	382	1,540
Number of maunds of colophony sold . . .	118	253½	380½	278	1,030
Number of gallons of turpentine sold or used . .	45	168	1,168	624	2,005
Revenue from crude resin R	46	800	15	68	929
" " colophony "	655	1,397	1,888	1,563	5,503
" " turpentine "	127	353	2,510	1,306	4,296
Value of resin and turpentine in stock . . "	...	...	...	2,773	2,773
TOTAL . R	828	2,550	4,413	5,710	13,501
EXPENDITURE.					
Capital	305	20	20	..	345
Working—					
Cost of collection . .	562	561	942	1,168	3,233
" carriage . .	234	428	766	808	2,236
Dehra expenses . .	95	260	363	432	1,150
Chakráta	124	218	471	} 819	2,866
Bags, drums, etc. . .	280	365	580		
Carriage by rail . .	89	182	254	163	688
TOTAL .	1,384	2,014	3,385	3,390	10,173

The net results consequently are:—

	R	R
Revenue		13,501
Expenditure, working	10,173	
10 per cent. of capital	35	
		10,208
Profit .		3,293

on 1,763¼ maunds of resin collected.

This is equivalent to very nearly R1-14-0 per maund profit. In 1891-92 200 maunds were sold in Chakráta at R4 per maund, which of course is much better; but it is believed that the purchaser lost money over it and since then there has been very little demand for crude resin. The introduction of a new industry is an important matter, and it is satisfactory to be able to show that the work pays. Were there a road along the Tons valley, the industry might be extended easily so as to supply, not only the present, but a much larger demand; and now that a new customs tariff taxes the imports of resin and turpentine into India, there is every reason for customers to get their supplies from the local industry. At the

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suggestion of the Inspector General, proposals are being prepared for increasing the number of stills and building a small shed for the work.

62. *Deodár oil.*—About 7 maunds of deodár oil has been distilled at Deota from the resinous chips of the deodár wood. The cost including carriage to Chakráta, amounted to R41-11-0. It is being tried by one or two purchasing firms, but the result is not yet known.

63. *Chír, Tar and Pitch.*—The demand for these articles has not improved, but small indents are being received and small quantities sent out for trial. The effects of the new customs tariff ought to be perceptible in the case of all these products.

64. Nothing further has been heard of the proposal to use fir wood for the manufacture of matches; but the question of its utilization for making tea boxes has been under discussion, and it is very probable that before long the Dún tea planters will get their supplies from Dakhpathar and enable us to dispose of much of our surplus fir wood, of which there is a large supply and for which the demand is at present insufficient. Enquiries have been made for woods of pretty grain for brush backs, and similar articles, and every endeavour will be made to assist in their being procured, through the medium of the purchasers of coupes.—(*Forest Dept. Report, N.-W. P., year ending 30th June 1894.*)

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G. I. C. P. O.—No. 100 R. & A.—28-7-96.— —B. N. D.

(Mineral and Metallic Series No. 6.)

THE AGRICULTURAL LEDGER.

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MAGNESIA.

[*Dictionary of Economic Products, Vol. V., M. 52.*]

REPORT ON THE MAGNESITE AREAS OF THE CHALK HILLS, &c., NEAR SALEM.

Note by C. S. MIDDLEMISS, B.A., *Geological Survey of India.*

INTRODUCTION.

ABOUT the middle of November last I received a communication from the Madras Government asking me to examine the above areas (G.O., dated 12th November 1894). Accordingly a good part of the cold-weather season of 1894–95 was spent in their study.

The main results of my examination are embodied in this report which deals with—

(1) The two areas of the Chalk hills.
(2) That of the north-west end of the Kanjamallai hill.
(3) That near Valaiyapatti in the Námakkal taluk.

Of these three areas the first is by far the most important. They will be taken for description in the above order.

(1) CHALK HILLS.

The two areas embraced under the above name have been described by Messrs. King and Foote in their Memoir (*Mem. G. S. of India*, vol. IV, pt. 2, 1864). The same areas were cursorily examined by Mr. Holland quite recently, and described (*Records G. S. of India*, vol. XXV, p. 135, 1892).

Whilst the two former observers gave a fairly detailed description of the mode of occurrence of the magnesite, with remarks on the accompanying minerals, the latter was able to come to more definite and accurate conclusions regarding the

mode of origin of the magnesite, chromite, etc.—conclusions which have been abundantly confirmed and illustrated by my own visit.

In taking up work myself on these extremely interesting rocks, it was clear (considering that a generally descriptive account, and an up-to-date theory of them existed already) that any advance that I could make on the work of my predecessors must be in the direction of greater accuracy as regards detailed surveying of the minerals and rocks of the area. My line of action was therefore clear, and the first step towards it was to obtain a detailed topographical map. This I found not to exist; and so, as the shortest way out of the difficulty, I set to work and plane-tabled the two magnesite areas of the Chalk hills myself on the scale of 6 inches to 1 mile, showing sketched contours of 10 feet. A tracing of the map, geologically coloured, accompanies this report.

It will be seen, therefore, that the apparently simple request of the Madras Government for further information about the magnesite of these hills was really a call of a more serious nature than would appear at first sight—if I were to see anything and report anything beyond what was already known and published.

Position and area

The Chalk hills lie a few miles north of Salem town. They comprise two areas, a smaller one to the south, through which at its south-west end the Madras Railway and the road to Omalur pass, and a larger one to the north-east of the latter, and which keeps a position to the east of the railway and road. The former contains about $1\frac{1}{4}$ square miles and the latter (so far as shown in my map) about $3\frac{1}{2}$ square miles. It extends, however, further away in a north-easterly direction.

Orography.

The hills rise gently from the plains, and expose a set of low undulating surfaces, generally bare of vegetation and without water. They are streaked with white, owing to the veins of magnesite (carbonate of magnesia) from which (erroneously) the name Chalk hills is taken.

General Geological structure.

The structure of the two magnesite areas may be summarised as follows:—

(1) The plains surrounding the Chalk hills are composed of an ancient gneissic series, wrapped into folds with a N.E.—S.W. strike.

(2) The two areas of the Chalk hills are essentially two great intrusive masses of olivine-chromite rock, and other olivine-bearing rocks, which, from their containing little or no felspar or quartz, belong to the peridotite, or ultra-basic group of rocks, such as dunites, picrites, etc These rocks, owing to the unstable mineral olivine, have undergone enormous mineral change, whereby, first the dunite became serpentinised more or less completely, and secondly, the serpentinised product was further altered with the formation of magnesite, chalcedony, etc.

The Dunite and its contained mineral Chromite.

Mr. Holland was the first to detect the presence of dunite in the specimens which he collected in the Chalk hills and north-west of Kanjamallai hill—see foot-note at p. 144 of Mr. Holland's paper.

This rock, first known from the Dun mountain, New Zealand, is composed entirely of olivine and chromite, and as such, in an unaltered condition, it is found at many places in the Chalk hills where the rock has resisted the metamorphic influences tending to convert it into serpentine. The top of "J" hill and of "Tent" hill, and the western end of the south area are examples of places where the rock, of a grey or greenish-grey colour, may be observed. The grey rock (colourless in thin section), such as is found on the summit of "J" hill and near "KK" hill, might be at first sight mistaken for a quartzite until the high specific gravity arouses suspicion.

The microscope shows the rock to be composed almost entirely of a coarsely crystalline aggregate of olivine, felted together, and with minute black crystalline grains of chromite dotted through it.

A chemical analysis of the "J" hill specimen No. 10·189, made in the survey laboratory by Mr. Blyth, gave—

Silica	39·10
Magnesia	48·26
	87·36
Iron, alumina	12·64
Manganese	
Chromium	
Moisture, etc.	
	100·00
The specific gravity was	3·176

I give below, for comparison, an analysis of the dunite of the Dun mountain (Von Hochstetter)—

Silica	42·80
Magnesia	47·38
FeO.	9·40

(after the chromite had been removed).

I next give that of oriental olivine, taken from Dana's Mineralogy :—

Silica	39 73
Magnesia	50·13
FeO.	9·19
The specific gravity being	3·351

There can be no doubt that originally nearly the whole of the Chalk hills area was composed of this extreme form of peridotite known as dunite. But mineral changes rapidly set in, and the two first of these changes that must be noticed are (*a*) the alteration, partially or wholly, of the olivine into serpentine, and (*b*) the segregation of the chromite into nodules and veins. With regard to the change of olivine into serpentine, I need say very little. It can be followed most perfectly under the microscope by a series of transitional sections showing, first, a few veins of the latter anastomosing among and penetrating the crystals of olivine, afterwards breaking them up, then separating them into isolated small grains set like islands in a sea of serpentine, and which at last become very small and finally disappear. The subsequent changes which brought about the conversion of much of the serpentine into magnesite have effectually destroyed any ornamental qualities it might have possessed, by giving it a dull earthy appearance. Only here and there do there occur a few minute veins, a finger thick, of a pale apple-green serpentine, which might, if they had been on a larger scale, have been of economic use. Picrolite or fibrous serpentine, is also found in veins here and there.

Coming to the chromite, originally discovered by Mr. Heath, and worked by the Porto Novo Company, the only observations we have as to its mode of occurrence are those made a long time ago by Newbold, and those of recent date by Holland. The former found the mineral in very thin veins, either lying among the magnesite of the veins or between it and the walls of the veins. The observations were drawn from an examination of the mines near the chimney on the accompanying map.

Holland corroborated Newbold's observations in this respect—see *Journal Roy. Asiatic Soc.*, vol. VII, 1843, pp. 167—171. Of the three shafts marked on my map, the middle one is the largest, and though I explored this carefully, I could find no trace of the mineral left in the crumbling rock-walls of the shaft.

In some small pits sunk along the position of the red line on the map (some of which appear to have been enlarged lately), I was able to see the position of several veins of the chromite. Three vertical parallel veins a quarter of an inch, 1 inch, and ½ inch wide respectively, and separated by a few inches of serpentinised matrix, occur striking E. 20° N. at a position on the map N.W. 5° N. from the chimney, and distant about 650 yards (see pl. I, fig. 1). Nearly horizontal magnesite veins may be seen interrupting and cutting across both the matrix and the chromite veins. In one place a vein of magnesite, has not only interrupted, but also displaced, the middle vein of chromite, showing that the magnesite was, in this case, the last to form.

What is undoubtedly a continuation of the same vein towards the E. 20° N. is to be seen at several points between 900 and 1,000 yards off. At no other places in this north area was chromite found *in situ*.

It will be seen from the map, however, that in this area a little east of the chimney there is a space of country from which six stream-beds radiate in different directions. In every one of these stream-beds, and especially in their higher parts, chromite, in lumps, varying from one foot to one inch or even less across, may be picked up (the places where such have been found are indicated on the map by red dots).

It is clear, therefore, that the area drained by these streams is penetrated by chromite veins. Unfortunately, my data are too scanty for any attempt to estimate the amount of chromite available to the miner; nothing but a practical test within the area of, say, 1,000 yards radius from the chimney would settle this all-important question. Geology has gone as far as it can, unaided, in the matter.

In the southern area of the Chalk hills the map similarly shows, by means of red dots, the places where chromite has been picked up at the surface. No chromite, actually *in situ*, is known in this area; but the indications of it in the stream

between "Tent" hill and "Green bush" hill, and in the one to the south-west of "Tent" hill, show that the centre of this area is approximately the true location of the chromite. No mines have been worked in the area, but I have no doubt that if extensive quarrying of the magnesite is ever carried out, chromite veins will in due course be laid bare.

As for the quality of the ore, the nodules and lumps as picked up among the hills show that it is practically a granular-crystalline aggregate of the pure mineral, chromate of iron, the theoretical composition of which, as given by Dana, is—

Chromium sesquioxide	68·0
Iron protoxide	32·0
	100·0

but chromite varies much in the amount of the sesquioxide present, 50 per cent. being considered a very good quality of ore.

The actual analysis of the ore, as found in the north area of the Chalk hills, is given in Newbold's paper referred to above. It was made by Mr. E. Solly, and gave—

Chromium sesquioxide . .	49·00 per cent.
Which is about equivalent to chromic acid	57·00 „

Or to cent. per cent. of chromate of potash.

The following description of the method of working and transporting the ore to the coast is taken from Newbold's report:—

"The ore is separated from the rock by means of pickaxes, chisels, "wedges, and hammers; sorted and piled up into little heaps on the "ground in front of the huts occupied by the superintendents, where "it remains until the Cauvery becomes navigable; that is, from the end "of June till the end of September. It is then sent down by land to "Moganoor, a place on the river about 40 miles southerly from Salem, "whence it is boated to Porto Novo on the Coromandel coast. Thence "it is shipped to Europe by the Porto Novo Iron Company."

About 100 tons are said to have been extracted from the mines, one block of which weighed two tons, but it was found that the export of the crude ore to England did not pay owing to the quantities available from Scotland, Styria, etc. At a depth of 50 or 60 feet from the surface water was met with, and it is not impossible that it was this difficulty which helped

largely to stop the work, inasmuch as no better means of removing the water were used than buckets and ropes.

Other Ultra-Basic, and Basic rocks of the Chalk hills

Besides the dunite, and its more immediately derived serpentine and chromite veins, there occur, somewhat sparingly, examples of other less basic rocks. They are generally black or of dark colour, and stand out in rounded lumps, having escaped the great alteration which the dunite has suffered. They are represented on the map by a purple colour. Many of these in the north area are situated round the margins of the dunite intrusion. One remarkable one is found to the east of "Green bush" hill in the south area All these rocks contain olivine, but not to the exclusion of everything else. They also contain green pyroxene, and sometimes black mica. Some also contain a small amount of plagioclase felspar, thus linking the ultra-basic rocks with the basic.

It is not absolutely certain how these rocks made their appearance in this area, but one reasonable hypothesis is that, lying as they do at the outer edge of the great dunite intrusion, they represent the lighter portions of the molten magna which separated at the surface, whilst the more basic elements of it tended to sink by their higher specific gravity and so occupy what is now a more central portion of the Chalk hills areas. But, as the study of these rocks is of more petrological interest than of economic importance, I do not propose to do more here in the way of describing them, but to confine myself to stating that, as they hint at an increasing basicity of the rocks as we travel inwards and downwards from the outer edges of the two areas, they point to the possibility of the heavier minerals, *e.g.*, chromite, being found in greater abundance at greater depths.

Another set of hornblende-garnet rocks which form the high ridge "HHJJ" between the north and south areas will similarly be neglected in this report.

The Magnesite veins.

I come now to the mineral which is most abundantly represented in the Chalk hills, that is, the magnesite, or carbonate of magnesia. Its general characteristics, mode of occurrence, and appearance have been described by many observers, among whom may be mentioned Newbold (*Journal Roy. Asiatic Soc.*, vol. VII, p. 161, 1842), King and Foote in their memoir cited above, and lastly Holland. The descriptions of the earlier observers

stand good at the present day, if we simply substitute the more correct mineralogical descriptions of the rocks from which it was originally derived in the place of the hornblende schists, micaceous and massive talcose schists, basalts, etc., of these observers. The mistake made by them (perfectly intelligible before the microscope was regularly employed for the examination of rocks by means of thin sections) was of a simple nature They looked upon the area of the Chalk hills as primarily a focus of metamorphism, brought about by a locally intense extravasation of hot acid waters or vapours, which were sufficient to change the otherwise stable minerals in the gneissic rocks surrounding the area Mr. Holland's and my own researches, on the other hand, have simplified the matter considerably by the discovery that the rock forming the groundwork of the Chalk hills areas is entirely different from the surrounding gneissic rocks; that it is in fact, as has been described above, a nearly pure olivine rock in various stages of alteration. The fact of such an olivine rock having at one time been erupted into the older gneisses in this part of the country is in itself sufficient to account for the secondary masses of serpentine and veins of magnesite, without having recourse to hot acid waters emerging at particular places; inasmuch as it is the nature of olivine rocks to rapidly undergo changes into serpentine and magnesite. The mineral is of such an unstable nature as to readily lend itself to these changes under normal subterranean or surface conditions (without calling into play any special metamorphosing agents), whilst the ordinary gneisses of the country, and the less basic rocks surrounding the area, remained practically unaltered.

I need say very little, therefore, as to the general occurrence of the magnesite here, except that it appears in veins, which although they have, in places, a tendency to a particular alignment, along what were probably originally joint planes in the dunite, are nevertheless as a rule completely irregular in their disposition. The number of veins, and the corresponding quantity of the magnesite, were points to which I particularly directed my attention; and which I have endeavoured to represent on the accompanying map. The pale wash of blue, which covers the whole area where the dunite is found, stands for that in which the magnesite is least in evidence or absent altogether. The cross-shaded portion is that in which there is a fair amount of the magnesite; whilst the deep-blue wash represents the parts

richest in magnesite. I have been compelled for diagrammatic purposes to draw the boundaries of the different areas as sharp, but I need scarcely remark that in nature there are no such hard and fast lines; the richer and the poorer rock grading into each other.

(1) The richest areas (coloured blue) are, generally speaking, the western end of the north area, and the south side of the south area. I estimate that the proportion, by volume, of magnesite in the rock in these richest parts is about one-half or one-third of the whole rock.

(2) The moderately rich area (cross-shaded) occupies generally the more central parts of the Chalk hills; and I estimate that the proportion, by volume, of magnesite here is only from one-sixth to one-tenth, or even less, of the whole rock.

(3) The poorest area (coloured pale blue) merely shows a few thin veins and patches of the magnesite here and there, and impossible of estimation.

The total area embraced under heading No. (1) above, in the two parts of the Chalk hills taken together, amounts to about 620,000 square yards, that under heading No. (2) amounts to about 5,536,000 square yards.

Considered altogether, the amount of magnesite in these hills is practically unlimited. The richest portions (as visible at the surface) stand up in rough lumpy hillocks, sometimes, as in the case of the hills at the western end of the north area, rising as much as 100 to 140 feet above the plains, whilst in other parts, as the south edge of the south area, they rise only to 30, 40 or 60 feet above the plains. Hence the mineral (if any demand for it ever does arise) can be worked in open quarries, and taken away to the rail. The quarries could all be reached by a light tramway, or by carts.

Two outline views of the two areas are appended to this report to show the configuration of the country, and two photographs to illustrate the surface appearance of the magnesite veins.

(2) Kanjamallai area.

Mr. Holland (*Rec. G. S. of India*, vol. XXV, p. 142) was the first, I believe, to draw attention to the presence of ultrabasic rocks and magnesite in small amount at the north-west end of the Kanjamallai hill in a depression at the head of a little

Magnesia. **The Magnesite Areas of the Chalk**

stream running down to Sithaswaran kovil (temple). Therein also he remarks on the possibility of finding chromite associated with the magnesite.

On visiting this part myself last season, I found the rocks as described by Mr. Holland. But the amount of the purer olivine-chromite ultra-basic intrusive rock (dunite) as found at the surface was, however, extremely small. It is of a pale greenish-yellow colour and crumbles easily. Veins of magnesite run through it. In close relation with it was a brilliant dark-green rock composed of enstatite and a bright-green pyroxene (diopside), a rock which is also found in the extreme north-east parts of the north magnesite area of the Chalk hills, on the east side of the double-peaked Nagramallai hill (not represented on the map).

Mr. Holland's prediction as to the possible finding of chromite here was verified by my coming upon a band of it about 4 inches thick among the magnesite and decomposed ultra-basic rock. It was only exposed for the short distance of about 3 yards.

The whole exposed area of these rocks in this locality is in length not more than $\frac{3}{4}$ mile and in breadth $\frac{1}{4}$ mile. It appears to follow round the eastern end of the depression at the north-west end of Kanjamallai in the angle formed by the main ridge and the low continuation of it south of Sithaswaran kovil (temple). I could not find any trace of it anywhere else on the Kanjamallai ridge.

To the south of Kanjamallai hill, and running parallel to, and north of, the Salem, Sankaridrug road, there is a little row of hills composed chiefly of talcose schists and dunite, with a mere trace of magnesite among them. The talcose rock was locally worked as pot-stone for making rude vessels (feeding troughs for cattle, etc.).

Both those two areas are too small to be considered as of any importance from the magnesite they contain; but the chromite of the former, and the pot-stone of the latter, may be considered as of some economic value. The chromite is in close proximity to a thick bed of magnetite.

This paper does not profess to deal with the iron ores of Kanjamallai, but I may mention that a few average specimens from the lowest and thickest band of magnetite schist at the

south foot of Kanjamallai were analysed in the Survey laboratory by Mr. Blyth and gave :—

No. 10·212 (a fine-grained, almost aphanitic rock, a large specimen of which I sent to the Madras Museum)—

Specific gravity	3·365
Per cent. of iron	35·00

No. 10·243—

Specific gravity	3·531
Per cent. of iron	34·390

No. 10·239 (a coarsely crystalline quartz-magnetite rock)—

Specific gravity	3·538
Per cent. of iron	36·66

(3) The Valaiyapatti area.

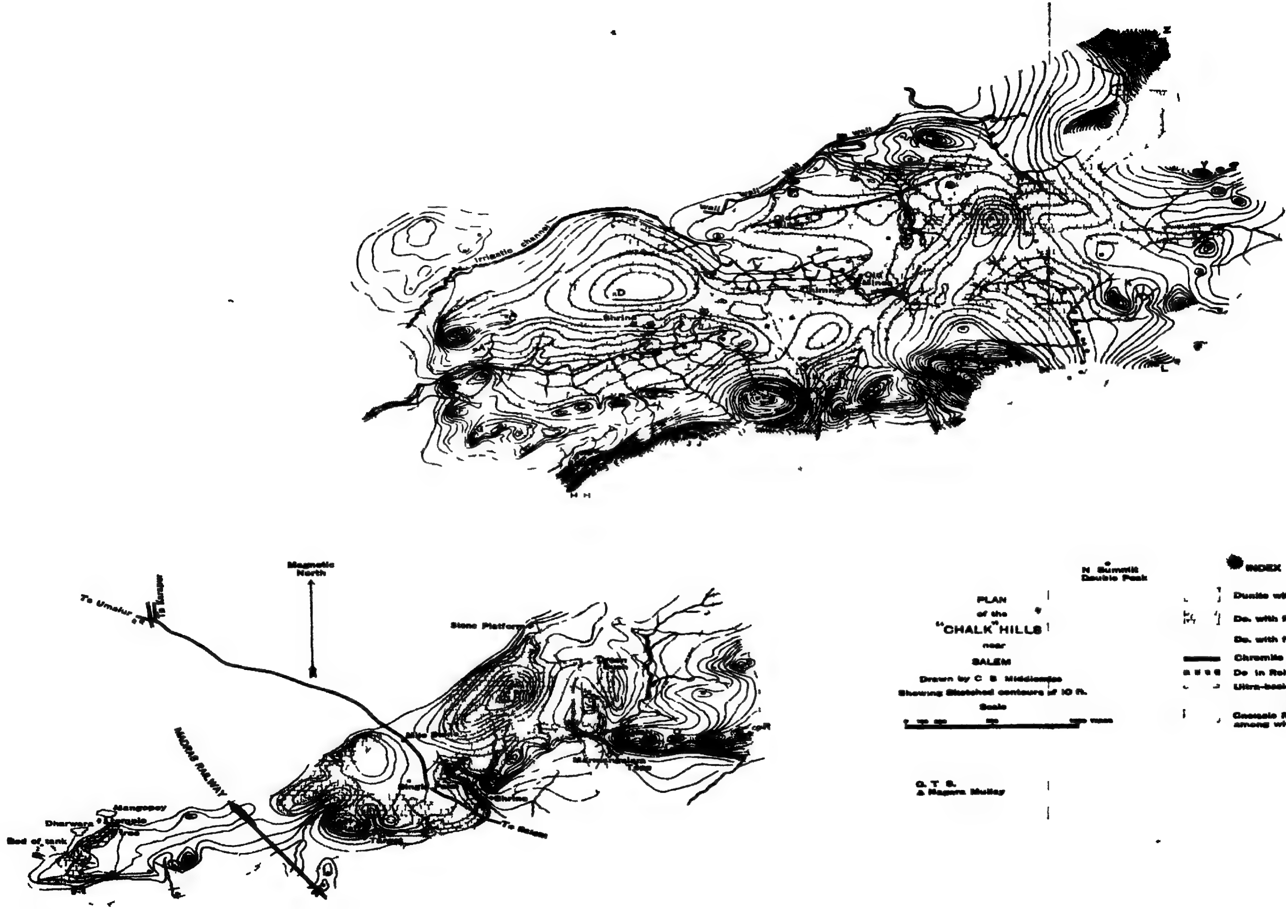
This locality is one of those described by Foote and King in their Memoir cited above, p. 96. The amount of magnesite present is extremely small. The ultra-basic rocks which have given rise to the magnesite are the same as those last described from north-west end of Kanjamallai hill, but I did not find any of the pure olivine rock analogous to the dunite of the Chalk hills.

The actual locality is a little south (from half to one mile) of Palappatti of the one-inch map of the Námakkal taluk (Madras Survey). The magnesite is exposed over an area of one mile by half a mile, and it is developed among rocks which contain a considerable quantity of enstatite, with green pyroxene (diopside).

Besides this particular area there is, actually at Valaiyapatti, another occurrence of similar rocks, which stretch away in a long narrow band east and west of the town. They form little hills rising sometimes steeply, and forming a discontinuous chain. With them east of the town occurs a rock of an extremely acid type, a very coarse red or pink and white pegmatoid rock or graphic granite, composed of quartz and felspar, which have crystallised together simultaneously.

From the point of view of this report I need not make any further remarks concerning this occurrence.

These are all the localities with magnesite that I have so far visited. The first is the only one in which the mineral is developed in sufficient force to be of any practical use.



PLAN
of the
"CHALK" HILLS
near
SALEM

Drawn by C S Middlemiss
Showing Sketched contours of 10 ft.

Scale

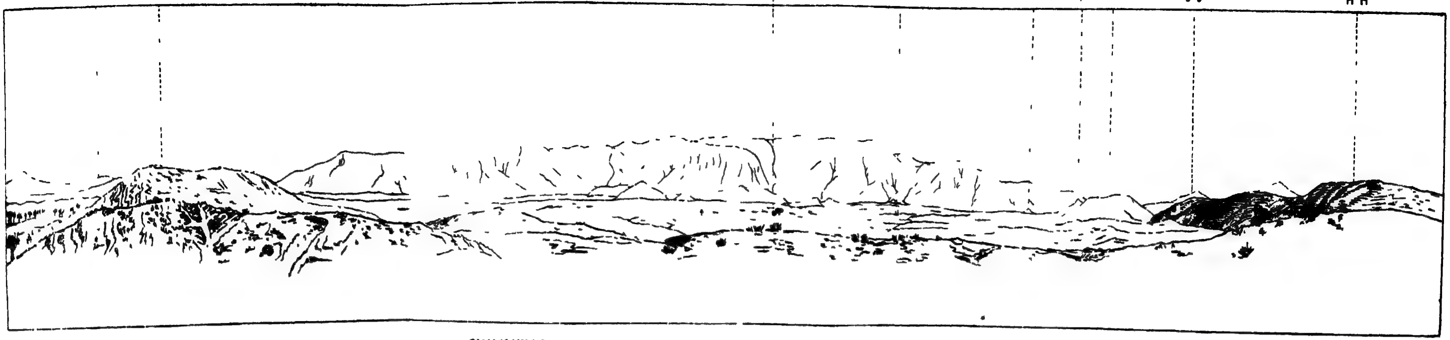
G. T. S.
& Magara Mulley

INDEX

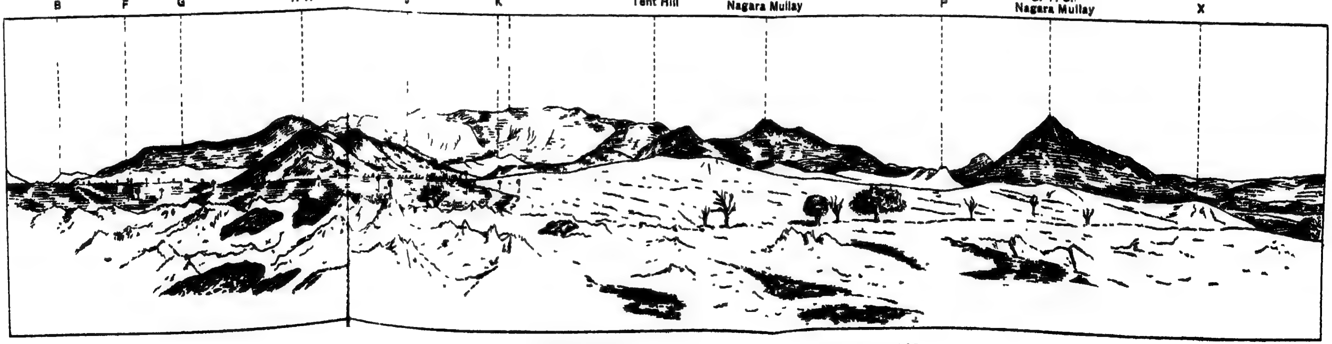
Dunite with a little Magnesite.
Do. with from ½ to ¼ Magnesite.
Do. with from ¼ to ½ Magnesite.
Chromite Vein
Do in Rolled fragments.
Ultra-basic Olivine-Augite, and Olivine-Augite-Plagioclase Rocks
Gneissic Rocks, striking about NErS. W. among which the above rocks are intrusive

Reg. No 26, Reporter, Econ Products India.—Feb 97—2 120

Photo., S I. O., Calcutta



CHALK HILLS, N MAGNESITE AREA, WITH SHEVAROYS BEHIND. FROM HILL "F."



CHALK HILLS, S. MAGNESITE AREA. FROM A LITTLE W OF OMALUR-SALEM ROAD.

Reg No 26, Reporter, Econ Products India—Feb 07—2,100

Photo., S. I. O., Calcutta.

PL. I.

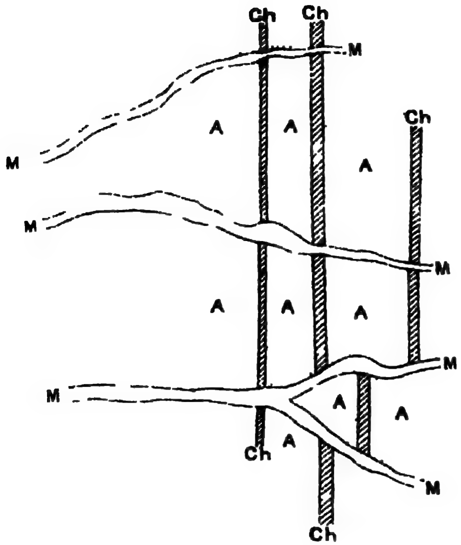


FIG. 1.

A = Serpentinised Dunite.
Ch = Veins of Chromite.
M = Do. Magnesite.

Scale
0 3 6 12 Inches

C. S. Middlemiss.
Report on the Magnesite Areas
of the Chalk Hills-Salem.

NOTICE.

It has been decided not to issue the illustrations to which allusion is made in the text.

with buckets made of leather, or fitted with valves, its superiority over leather or valve buckets becomes greater as the depth of the well increases. The lift taken as a whole also gave good results on trial, and might have been worked with a much smaller bullock.

M.R.Ry. Subba Rao's see-saw lift can be used with any bucket The iron bucket with a leather discharging trunk used during the experiment was not in good order. This lift also gave remarkably good results, but, as pointed out by Mr. Chatterton, the design cannot as yet be regarded as having reached its limit of perfectibility Its merits are described in Mr. Chatterton's note, and mainly lie in utilising the force exerted by the bullock and driver in ascending an inclined plane It is in its essence a picottah in which one bullock, by its mere weight, does the work of several men. As the length of the oscillating platform must be limited by considerations of weight and cost, the design is not adapted for wells in which the water is more than 30 feet below the ground level.

Regarding both the above lifts, the Committee is of opinion that whilst they are much more efficient than the single mhote, and whilst they, in common with the double mhote, cause much less wear and tear on the bullocks employed, it would require more skill to erect and keep them in working order than is usually available in up-country villages and that to enable the village blacksmiths to do this work, their training would have to be improved. As to the cost of the lifts, it is not possible to give any definite information; but the Committee considers that either might be put up for about Rs. 150, though the charges for Subba Rao's lift would vary greatly according to the materials locally available. Where palmyrahs are plentiful and cheap it might be possible to design and erect a see-saw platform at a cost well within the means of the ordinary ryot. It must be remembered that the ordinary single mhote, as used in Southern India, does not cost more than about Rs. 20.

As regards M.R.Ry. Subba Rao's new lift, wherein the action is the same as in the single mhote, except that the weight of the bucket is counterbalanced, and the bullocks are enabled to reverse at the end of the incline and walk up the slope, the Committee is of opinion that, where cattle labour is scarce, the contrivance should prove most valuable, being well within the means of the ryot, and within the capacity of the village artisans to erect. The Committee considers that Mr. Subba Rao is deserving of great commendation for the ingenuity and perseverance displayed in his efforts to devise an improved water-lift, and deems it a matter for regret that he is under the disadvantage of not having been trained as a mechanical engineer.

(Signed) H. M. WINTERBOTHAM.
(„) C. BENSON, M.R.A.C.
(„) A. CHATTERTON, B.Sc.

MADRAS,
22nd August 1895.

A. 647

Mr. CHATTERTON'S REPORT.

Three water-lifts were submitted to the Committee for trial: (1) a water-lift with self-tilting buckets by Mr. E. W Stoney of the Madras Railway, (2) an improved single mhote by M.R.Ry. Subba Rao, (3) a water-lift worked by an oscillating platform also by M.R.Ry. Subba Rao. The Committee also experimented on the old double mhote erected at the Saidapet farm about twenty years ago, and which, in its present condition, represents the average of high-class water-lifts working in southern India. Hitherto no reliable experiments have been made on the efficiency of the various forms of water-lift worked by animal power which are in common use, and the Committee, in carrying out the investigations necessary to form an opinion on the matter submitted to them by Government, determined to remedy this as far as possible, recognizing that the only way in which improvement can be effected is by the compilation of accurate data regarding the different types of water-lifts already in existence. The experiments conducted by the Committee had the following objects in view :—

The determination of—

(1) the quantity of water and the effective height it was lifted in a given time by bullocks of known weight, and working in a way that did not unduly fatigue them ;

(2) the quantity of work actually obtained from the animals in the same time ;

(3) the quantity of work which might have been obtained from the animals in the same time had the working of the lifts been continuous.

The first quantity divided by the second gives the mechanical efficiency of the water-lift, and the first quantity divided by the third gives its absolute efficiency as a machine for utilizing animal power in a given way.

(4) The quantity of work represented in the water lifted per hour divided by the weight of the bullocks in lb.

This yields a constant which, on the assumption that the animals employed in working the various lifts are all equally strained, enables a comparison to be made between very different types of water-lift and very different methods of applying animal power. In some lifts only the draught of the animals is utilized, in others, as for instance, the ordinary single mhote, both draught and weight are utilized, whilst in a third class only the animals' weight is made use of as in Mr. Subba Rao's oscillating platform, and between such very different methods the constants yielded by (4) seems to be the best method of making comparisons of the actual value of different machines for lifting water. It must be remembered that though the mechanical efficiency of a water-lift may be high, yet the mode of getting work out of the animals employed may be bad, and the actual value of the water-lift therefore small. The value of the constants yielded by (4) depends on the assumption that the strength of animals is proportional to their weight, which is probably roughly true for animals in good working condition

and in the prime of life, and on the accuracy with which it is possible to estimate whether two animals working in different ways are exerting themselves to their full working capacity. The figures therefore obtained are only to be taken as offering a rough method of comparing the different lifts and as a guide in estimating their probable value as machines for lifting water.

Methods of measurement employed in the experiments.—All weights were determined and draughts measured with a Salter's spring balance, recording to 500 lb and indicating differences of half a pound, which, previous to the commencement of the experiments, was tested with dead weights in the College of Engineering and found to be accurate. The quantities of water raised were measured in the case of Stoney's lift by counting the number of buckets emptied and multiplying that number by the contents of one bucket. As there was no leakage, it was found that each bucket came up with practically the same quantity of water in it, and by weighing that quantity it was possible to obtain a very accurate determination of the total quantity of water raised. In the other lifts, iron buckets with leather discharging trunks were used, and, as they all leaked to a certain extent, the quantity of water raised was determined by multiplying the total number of lifts by the average quantity lifted in a single bucket obtained by taking the mean of a number of buckets measured in an iron tank capable of holding about 250 gallons. Speeds and times were measured with a stop-watch recording fifths of seconds. Measurements of draught and friction were made by inserting the spring balance, which was used as a dynamometer, in the line of action of the forces exerted by the bullocks and employing a number of coolies to work the lifts in their place. In machines like water-lifts, which, of necessity, are somewhat roughly constructed, no great amount of labour is expended on fitting the moving parts together, and in consequence the working is not perfectly smooth and the friction varies considerably in a single operation of the machine. The measurement of draught is therefore not very easy, and the results given below are, in every case, the mean values obtained from a large number of observations.

Stoney's water-lift.—The principal feature in this lift (Plates II and III) is the employment of buckets of wrought iron suspended in a stirrup by two adjustable pivots attached to the bucket very slightly above the centre of gravity of the bucket when full of water. The mouth of the bucket is inclined as shown in the drawing, and the lower ends of the stirrup are turned outwards and encircle steel wires which are suspended in the well from screwed eye-bolts attached to the framing above. The wires are fastened by some convenient means to the bottom of the well and act as guides to the bucket, ascending and descending, and prevent it from either turning round or swaying to and fro and thus striking either the sides of the well or the second bucket. On the bucket being lowered into the water, it turns horizontal and rapidly fills with water, and on being drawn up assumes a vertical position and rises steadily out of the water till the discharging level is reached, when the upper side of the inclined mouth comes into contact with an iron bar fixed

across the framing of the lift, and the stirrup, continuing its upward motion, causes the bucket to revolve about the point of contact of the bucket with the iron rod, and thus discharge its contents into the delivery trough. The lift, as arranged at Saidapet (*vide* Plate I) during the trials conducted by the Committee, was worked by carrying the ropes which hold the buckets over guide pulleys to a whim turned by either a pair of bullocks or a single bullock. Two buckets were attached and the ropes arranged, so that as one bucket ascended the other descended and the dead weight of the buckets was balanced. The whim consisted of a drum built of wood and carried by an iron spindle on the top of a post firmly built into the ground. The bullocks worked at the end of a long arm, the circumference swept out by which was 3·85 times the circumference of the drum. The whim is worked alternately in one direction and the other, the cattle being made to turn round whilst the bucket is discharging its contents. The lift was provided with two sets of buckets of a nominal capacity of 30 and 25 gallons respectively. In the following table is exhibited the data regarding their capacity :—

TABLE I.

		Weight empty.	Weight of water when full.	Weight of water delivered by buckets
		LB.	LB.	LB.
30 gallon buckets .	No. 1	101	296	280
	No. 2	98	295	280
25 gallon buckets ...	No 1 ..	68	245	230
	No. 2 ...	67	237	230

The capacity of the lift was tested by working it with a single Nellore bullock weighing 1,146 lb. on three different days, but, owing to insufficiency of water in the well no test could be continued for more than 2 hours 42 minutes. In table II the results obtained are shown :

TABLE II.

Date.	Time started.	Time stopped.	Number of buckets raised.		Lift at beginning.	Lift at end.	Mean Lift.	Gallons raised per hour	Foot pound of useful work done
16-7-95.	8-37	9-37	88	30-gal. buckets.	22′ 0″		22·625	2,594	586,900
	9-37	10-07	51		..	23′ 3″	.	...	...
	2-4	3-4	91		21′ 10¼″		...	.	...
	3-4	4-4	86		.	...	23·24	2,469	575,500
	4-4	4-46	63			23′ 6″	...	...	..
17-7-95.	2-0	3-0	85		22′ 2″	..	22 87	2,391	546,900
	3-0	3-51	73		...	23′ 6¼″	...	...	..
18-7-95.	2-29	4-29	167	25-gal. buckets.	22′ 2″		22·75	1,886	429,060
	4-29	5-29	79		.	23′ 4″	...	.	...

The results obtained with the 25-gallon buckets compare unfavourably with those obtained with the 30-gallon buckets as the animal employed was evidently not doing as much work as he might easily have done. His natural gait determines the number of lifts he can make per hour and the number is practically the same with the smaller as with the larger buckets He could easily lift the 30 gallon buckets; a smaller animal should therefore have been employed to work the 25 gallon buckets.

The following observations were made on the draught required to work the lift, and the friction when working. The length of rope to go once round the drum was 19·33′ and the circumference of the path in which the bullock walked 74·33′ so that the velocity ratio was 3·846 With both buckets empty, it was found that a weight of 30 lb. placed in one bucket was sufficient to overcome the friction and cause that bucket to descend and the other to ascend at a uniform velocity. With 28 gallons of water in each bucket, 52·5 lb was found necessary to set the whole water-lift in motion at a uniform speed. To work the lift at about the speed at which it was worked by the single bullock, it was found necessary to exert a pull of 92 lb. at the end of the lever attached to the whim, whilst a pull of 87 lb. was found sufficient to just set the buckets in motion With one bucket full and the other empty, it was necessary to exert a pull of 57 lb at the end of the lever arm to prevent the full bucket from falling back into the well. Half the difference between 87 and 57, or 15 lb., represents the pull that is required to just overcome the friction of the mechanism. The mean between 87 and 57, or 72 lb. represents the pull which must be exerted to raise a full bucket neglecting friction, and this quantity multiplied by 3·85 should be equal to the weight of water in the bucket, viz., 280 lb.; actually it is equal to 277 which is a very accurate result considering the roughness with which the apparatus is constructed. From these figures it is easy to deduce that the mechanical efficiency of the lift when just moving is 83·6 per cent. and at the ordinary working speed 79 per cent. It was found that the speed at which the bullock walked when exerting a draught of 92 lb. was, as the mean of a number of observations, 3·646 feet per second and that in 162 minutes he raised 240 buckets of water, lifting each bucket 23 feet. Walking at this speed without stopping, which, without doubt, the animal could have easily done, he could have lifted 401 buckets, so that he was only usefully employed for 59·7 per cent. of the time. The absolute efficiency of the lift was therefore 0·79 × 59·7 per cent. or 47·2 per cent. This calculation neglects to take into account the extra pull which is necessary to tilt the bucket to make it discharge, which was found to amount to 122 lb. and which was exerted through about 3 feet. This quantity would only affect the result very slightly and the decrease in efficiency would diminish, as the height to which the water has to be raised increases.

Improved Single Mhote of M.R.Ry. Subba Rao.—The improvement (Plate IV) on the ordinary single mhote is effected by attaching a rope to the draught rope and carrying it on to the large drum of a kind of windlass erected at the end of the inclined plane and at a consider-

able height above the level of the end of the run. Cords wound round two smaller drums, one on each side of the large drum, carry weights, which it was found almost balanced the weight of the empty bucket, so that at the end of a lift, as soon as the bucket was empty, the draught rope automatically rose in the air and the bullocks were able to turn round and walk up the inclined plane in a natural easy manner instead of being forced backwards as is the common plan. The improvement effected is undoubtedly a very great one, as not only is the weight of the empty bucket practically balanced, but the animals are also spared the cramped and unnatural backward walk up a steep incline which probably tires them more than their exertions in drawing the bucket out of the well. The experiments made on this lift were not very extensive, but the following results were obtained and are worthy of record. The mhote was worked by two bullocks weighing 732 lb. and 616 lb. respectively, or in the aggregate 1,348 lb. The bucket, which was of iron and fitted with a leathern discharging trunk, weighed 43 lb and when full held 31 gallons of water, but the mean quantity lifted, as measured into a tank, was 24·2 gallons per lift, the rest being spilt or lost by leakage. With the bullocks employed, the rate of working was 90 lifts per hour, and the height of the lift being 23 feet, the total quantity of work usefully done amounted to 500,940 ft.-lb. per hour The draught exerted by the bullocks down the inclined plane was found to be 383 lb. The useful work done in a single lift was $24{\cdot}2 \times 10 \times 23$ or 5,570 ft.-lb., whilst the bullocks exerted a pull of 383 lb through 25½ feet, the bucket having to be raised an extra 2½ feet to enable it to discharge its contents, and the work done is equal to 9,760 ft.-lb. The bullocks then had to return up a gradient of 1 in 5·28 feet, in doing which they expended 6,510 ft.-lb. of energy in lifting their own weight against the action of gravity. The total amount of work done by them in a single lift was therefore 16,270 ft.-lb. and the useful outturn 5,570 ft.-lb., so that the efficiency of this method of lifting water is not greater than 34·3 per cent. As compared with the ordinary single mhote, the great advantage which this lift possesses is that it allows the bullocks to turn round at the bottom of the inclined plane and ascend walking forwards instead of backwards, an advantage which it would be difficult to express numerically, but the balancing of the bucket diminishes the draught by about 40 lb. and increases the efficiency of the lift by about 6·3 per cent., not perhaps a very large amount, but still by no means a negligible quantity.

See-saw water-lift of M.R.Ry. Subba Rao.—An attempt was made to erect one of these water-lifts at Saidapet, but it was not ready at the time of the Committee's trials, and in its place Mr. Subba Row asked the Committee to report on a lift which had been in use for some months in a garden in the Luz. In this form of water-lift (Plate V), the bullock is made to walk along a platform supported on a roller, and by his weight it is caused to oscillate up and down. Two ropes are attached to one end of the platform and wound round two small drums forming part of a species of windlass, round the large drum of which a rope working an ordinary single mhote is passed. The platform is not supported

in the middle, but at some distance therefrom, so that the working end of the platform greatly preponderates and the bullock has to walk to the free end of the platform to tilt the longer segment up and lower the bucket into the well. The platform is 24 feet long and the supporting roller is fixed 15 feet 3¾ inches from the working end. It was not possible to weigh the platform, and calculations of its weight based on the quantity of timber used in it can only be approximate. It was however carefully measured up, and assuming that the teakwood, of which it was constructed, weighed 45 lb. per cubic foot, the weights of the two sections are 1,450 lb. and 850 lb. To diminish the shock when the free end falls and the bucket is lowered into the water, 230 lb. of iron rails are fastened underneath the platform by a short chain, so that just before this end of the platform reaches its lowest position, the rails rest on the ground and their weight ceases to act, and the platform comes to rest more gently than would be case if the velocity of descent continued to accelerate to the very end. The ropes from the platform were wound round drums, the circumference of which was 3 feet 2¼ inches as measured by unwinding one coil of the rope, and the mhote rope was worked from a drum 7 feet 10 inches in circumference, so that the motion of the working end of the platform was multiplied 2·443 times. With the bucket empty and the platform horizontal, the load at the free end could be varied from 160 lb. to 362 lb. without disturbing the equilibrium, whilst with a load of 247 lb. in the bucket equal to 24 7 gallons of water, the platform remained horizontal, though the load at the working end varied between 584 lb. and 275 lb. Taking the mean between the two extreme values to be the actual weight required to balance the platform, it is possible by taking moments about the centre to determine the only force acting on the platform which was not measured, viz., the weight of the empty bucket and ropes acting with a leverage of 2·443 to 1. With the bucket unloaded, the weight works out as 65·4 lb. and when loaded, 62 lb.—a remarkably close agreement. The lift was worked during the trial by a bullock weighing 700 lb. and a man weighing 117 lb. The rate of working was 81 lifts per hour from a well 18′ 1″ deep. The average quantity of water brought up by the bucket, as measured into a tank, was 23·5 gallons, and the useful work done per hour amounted to 344,210 ft.-lb. The bullock and the man together were much heavier than was really necessary, and they did not use the full length of the platform, so that it is difficult to estimate the work done by them in working the lift, but the mechanical efficiency of the lift on the day of the trial can be ascertained by multiplying the fall of the front end of the platform by the force required to set it in steady motion when lifting a bucket full of water. The total height the bucket had to rise to discharge its contents was 22 feet, and the end of the platform therefore fell 9 feet and the work done was $584 \times 9 = 5{,}256$ ft.-lb. To raise the platform back to its initial position, the free end then falls 5·18 feet and the load on it is 362 lb. and the work done is equal to 1,875 lb. The total work therefore done in a single lift is 7,131 ft.-lb., and the useful work given to the water is 4,245 ft.-lb., so that the mechanical

efficiency when just working is 59·6 per cent.; at the normal rate of working it is much lower, probably not more than 50 per cent

The double mhote at Saidapet.—This water-lift is described in the *Saidapet Farm Records* by Mr. C. Benson, and though not in very common use in the Presidency is sufficiently well known to need no description. The details and general arrangement are shown in Plates I and VI This lift was worked by the bullock that was employed in the experiments on Mr. Stoney's water-lift, and as the draught was practically the same in both lifts, the results are strictly comparable The buckets were of iron with leather discharging trunks and were in good order and discharged an average of 28 gallons per bucket as measured into a tank The trial lasted 3 hours, and in that time 200 buckets of water were raised The mean lift was 22·125 feet and the useful work done per hour was 413,000 ft.-lb. The circumference of the drum of the whim was 12 feet 11¼ inches, and the circumference of the circle in which the bullock walked was 60 feet 9 inches, so that the velocity ratio was 4·67 The pull on the dynamometer at the ordinary speed of working was 90 lb. and the pull to just prevent a full bucket descending 59 lb. and the pull to just raise a full bucket 81 lb. The mean between these last two quantities, 70 lb., is the force at the end of the lever arm required to balance a full bucket of water when friction is eliminated. Multiplying by the mechanical advantage, the unbalanced weight is 327 lb—a result probably not very much in error, as the water in the bucket weighed about 300 lb. The mechanical efficiency of the lift just moving is therefore 74 per cent. and working at its normal speed 66·6 per cent The lifts averaged 1·111 per minute, and the animal was therefore usefully employed for 52·5 per cent. of the time, and the absolute efficiency of the lift as a machine for utilizing the energy of the bullock is 0·66 × 52·5 or 35 per cent.

Summary of the results.—To facilitate comparison the results given above are collected in the table below :—

TABLE III.

—	Mr. Stoney's water-lift	Double mhote at Saidapet	M.R.Ry Subba Rao's improved single mhote	M.R.Ry Subba Rao's see-saw water-lift
Useful work in ft.-lb. per hour, A	571,500	413,000	500,940	344,210
Weight of animals in lb., B	1,146	1,146	1,348	700
$\frac{A}{B} = C$ ...	498	360	371	492
Mechanical efficiency just moving .	83·0 %	74 %		59·6 %
Mechanical efficiency at working speed.	79 %	66·6 %	34·25 %	
Absolute efficiency ...	47·2 %	35 %		

Owing to the entire absence of leakage and the superior design of all the mechanical details, Mr. Stoney's water-lift has the highest mechanical efficiency and the highest absolute efficiency. The simple arrangement by which the bullock is yoked to the lever arm which is also used in the Saidapet double mhote and the rapidity with which the self-tilting buckets discharge their contents are the principal factors which contribute to the attainment of the high time efficiency. The value of the constant C is practically the same as that obtained with the see-saw water-lift of M.R.Ry. Subba Rao; but it is possible that the bullock employed might have been able to work with buckets holding more than 30 gallons of water, say 35 gallons, in which case the value of C would have been materially greater; but it was a point the Committee were unable to decide as no larger buckets were available It is not likely that any great improvement can be made in the design of the lift, though prolonged experience of it at work will reveal the weak points, and the details can be simplified. The framing supporting the buckets was in the lift at Saidapet unnecessarily complex, and Mr. Stoney has prepared designs of very much simpler forms of framing, which can be used for lifts permanently erected over any well. The buckets might probably be made a little lighter, and the lip which comes in contact with the tilting bar requires thickening to prevent the burring of the edge which at present takes place Owing to the employment of a single lever arm, there is a certain amount of bending stress on the spindle which carries the drum, and experience will probably show that the wooden post and spindle are scarcely stout enough. The arrangement for adjusting the length of rope to the depth of water in the well is very neat and simple From a ryot's point of view, the use of a number of nuts and bolts is an objection which is likely to be urged, but which may be partly met by designing the details, so that only one size of nut and bolt is used throughout the machine. The self-tilting buckets also require to be very carefully hung from their stirrups, and though the extra pull required to overturn them is diminished by hanging them, so that the equilibrium is nearly unstable, yet experience will probably show that in the hands of the ryot the lift will work more satisfactorily if the equilibrium is a little more stable. The tendency to spill just as the bucket comes out of the water will then be diminished, and the work on the guide wires to keep the buckets steady will be less. By making the ratio of the diameter to the depth of the bucket greater, the effort required to tilt them would diminish and they would discharge even faster than they do now, but experience with buckets of different proportions will alone show whether any appreciable improvement can be effected in this direction. The guide wires render it practicable to employ iron buckets in rocky wells, as there is no fear of the bucket being damaged against the side of the well, and by covering the bottom of the well, with a foot of sand or by placing a sand bag at the bottom of the well, the danger of the buckets being destroyed by rough usage is greatly decreased. From a mechanical point of view the whim would be improved by the introduction of an automatic reversing motion to obviate the necessity of turning the animals at the end

of each lift, but it would not compensate the ryot for the extra cost and extra complication this change would involve. The whim can only be satisfactorily worked by a single bullock, as the diameter of the circle in which they walk is so small that with two animals the inside one always works at a great disadvantage, and to increase the length of the lever arm is to introduce other disadvantages. The power of the animal is entirely utilized through his ability to exert a draught, and it is a well-known fact that walking straight forward the power to draw is considerably greater than when walking in a circle It is commonly assumed that the pull exerted by a horse walking round a circle of 25 feet diameter is only 60 per cent of that which he can exert when walking in a straight line, but the data from which this result was deduced are not available. Probably with bullocks the loss of power does not exceed 20 per cent., as they are smaller animals with shorter legs, but though uncertainty may exist as to the amount of the loss, there is no doubt that there is a loss and that it is a disadvantage inherent in all water-lifts which employ whims.

The single mhote, although very largely employed, is a very inefficient machine, and its prolonged working involves a very great strain on the cattle. The simplicity of the machine, however, compensates for its inefficiency, and the merit of M.R.Ry. Subba Rao's improvements chiefly lies in the fact that, without introducing any expensive or complicated additions, he has balanced the weight of the empty bucket and rendered it possible to turn the bullocks at the end of each run, so that they may walk up the incline in a more comfortable and expeditious manner than in the original lift. The additional gear involved can be fitted to any existing single mhote, and it is probable that, if it becomes known to owners of single mhotes, it will be largely used.

M.R.Ry. Subba Rao's see-saw or oscillating water-lift can be worked with any type of bucket, and it was undoubtedly not being worked to advantage when tried by the Committee as the bucket was an iron one of the old-fashioned mhote type and was not nearly as large as it might have been. The design was far from perfect and the mechanical efficiency was very low, yet the constant C obtained by dividing the useful work done in ft.-lb. per hour by the weight of the animal is nearly as high as for Mr. Stoney's water-lift. With a better type of bucket and one of larger capacity, the constant would certainly have been much higher. In its present condition, it would be useless to criticize the details of the lift which requires to be put into the hands of a good mechanical engineer to bring out the many merits which this method of applying animal power to the performance of useful work possesses. The animal does work by raising his own weight against the action of gravity, and without going into a lengthy discussion of the various methods of getting work out of animals, it may be asserted without fear of contradiction, that an animal can do more work in a given time with the same amount of exertion when that work consists in storing potential energy in his own body than in any other way. The difficulty is to devise a simple and cheap means, whereby that potential energy can be converted into useful work, and it would appear that

M.R.Ry. Subba Rao has probably arrived at a practical solution of the problem. In principle, the working of the lift in no way differs from that f the picottah, and not one of the least of the advantages which it possesses is that it is capable of being worked by coolies and in a very efficient manner should cattle from any cause not be available to work it. With every water-lift there must be a man employed to drive the bullocks, and in other forms of motor, this work, whatever it may amount to, is wasted, but in this form of motor, the work done by the man is usefully employed It is partly due to this that the constant C has such a high value Below are given two equations showing the forces acting on the platform when it is in horizontal equilibrium (1) when the bucket is empty and the animal is at the free end, (2) when the bucket is full and the animal is at the working end No account is taken of the friction which necessarily exists and which will consequently diminish the quantity of water which can be lifted by an animal of a certain weight:—

Let x length of long arm of platform.
x^1 — distance of centre of gravity of bullock from fulcrum along long arm
y length of short arm of platform
y^1 — distance of centre of gravity of bullock from fulcrum along short arm.
W_1 = weight of long arm.
W_2 = weight of short arm.
A_1 = weight of bucket when empty.
A_2 — weight of the water when the bucket is full.
B = weight of bullock.
V = velocity ratio of windlass

Then when the bucket is empty—

$$(1)\quad W_1\left(\frac{x}{2}\right) = W_2\left(\frac{y}{2}\right) + By^1 + VA_1 x.$$

$$(2)\quad W_1\left(\frac{x}{2}\right) + Bx^1 = W_2\left(\frac{y}{2}\right) + (A_1 + A_2) Vx.$$

Subtracting (1) from (2) we get

$$B(x^1 + y^1) = VA_2 x,$$

$$\text{that is } A_2, = \frac{B}{V}\left(\frac{x^1 + y^1}{x}\right).$$

The preponderance of the working end of the lift should, therefore, be such that it is necessary for the bullock to go to the free end to cause it to descend, and the weight of water which should be drawn up each time should be equal to $\frac{B}{V}\left(\frac{x^1 + y^1}{x}\right)$ multiplied by a coefficient which will be less than unity in proportion to the percentage of power wasted in friction. In the lift designed by M.R.Ry. Subba Rao, the preponderance of the working arm was not sufficient, as it required only 362 lb. at the free end to cause it to ascend, whilst it required 584 lb. at the working end to set it in downward motion. The bullock and the man working the platform cannot, of course, put their whole weight on the extreme ends of the platform, but it is possible for their centres of gravity to

approach within 2 feet of the ends which would make the values of $x^1 + y^1$, 13 feet and 7 feet respectively, and the value of $\frac{B}{V}\left(\frac{x^1 + y^1}{x}\right)$ with a bullock weighing 700 lb. and a man 117 lb would be 445 lb. equal to 44½ gallons of water. Allowing for obliquity of action at the beginning of each oscillation and for friction by the use of a coefficient of 0·75, which, with a properly-designed lift, should be attainable, the quantity of water lifted might reach 33 gallons, whereas it was only 23·5 gallons. With a heavier load, the lift would have worked better, and though possibly the time of ascent of the bucket from the well would be slightly longer, the effect on the total number of lifts per hour would be almost inappreciable, as the time efficiency of this lift depends mainly on the turning of the bullock at the ends.

A question of some importance in connection with this oscillating platform is the gradient which it assumes when in the extreme positions. In the lift in the Luz, the length of the platform was 24 feet and the rise and fall of the working end 9 feet, so that the slope which the animal had to walk up was 1 in 2·66. With a long platform, the period of oscillation will be slow, and it will therefore work more steadily than with a short platform, the gradient will be less and the animal will be able to ascend it easily, but the greater the length, the heavier the platform becomes and the more expensive it will be. There will be some particular gradient on which the animal can do most work, which can only be determined by experiment, and as this will be largely influenced by the nature of the surface the animal has to walk on, attention should be directed to this point. In the matter of gradient, the lift at the Luz appeared to be satisfactory, but the nature of the foot-hold seemed to leave room for improvement.

The initial cost of setting up a water-lift is a point of supreme importance to the ryot, and in this respect the improved water-lifts submitted to the Committee compare unfavourably with those in use at the present time. This is a difficulty which cannot be got over, and if the ryot wants, and there is no doubt that in many districts he does, a better machine for lifting water from wells he will have to face a greater capital outlay. During the greater part of the irrigation season, there are, in many places, a large number of unemployed cattle available for working water-lifts, and in such places the introduction of improved water-lifts is likely to make slow progress, but where more water is wanted than can be obtained by existing methods, experience of sugar mills and iron ploughs shows that the ryot is not slow to adopt an innovation if he finds that he really benefits thereby. Between the two water-lifts submitted to the Committee, there is not likely to be any great difference in price, but what difference there is will probably be found to be in favour of Mr. Stoney's invention. Next to initial outlay comes the question of maintenance and repairs, and on this point it is, without prolonged experience of their working, difficult to express any decided opinion. To erect them and keep them in working order requires more skill than is usually available in the villages, and they can only come into extensive use by improving the skill of the ordinary

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country blacksmiths. To do this will no doubt be a far from easy task, but it is one that might well be taken up by the technical side of the Educational Department. If a demand for skilled fitters and smiths arises, it should be possible for the various technical and industrial schools in the Presidency to meet it.

MADRAS, (Signed) A CHATTERTON, B.Sc.

21*st August* 1895.

ADDENDUM.

Since writing the above report I have been informed by Mr. W. Keess, the Principal of the Agricultural College, Saidapet, that the assumption, that the amount of work which draught animals can do is approximately proportional to their weight, is one which is generally accepted by agricultural authorities. He also informs me that draught animals, working steadily an average of 8 hours a day, can do 2 foot-tons of work per pound of their weight per day. It must of course be clearly understood, that such work is entirely external and is not part of the energy expended in the muscular action. In table III of the report, a summary of the experimental results is given from which it is easy to calculate the number of foot-tons of work done per pound weight of the animals employed in working the four lifts upon which experiments were made This calculation has been made with the following result:—

	Foot-tons of work per lb. weight.
Mr. Stoney's water-lift	2·253
Double mhote at Saidapet	1·930
M.R.Ry. Subba Rao's improved single mhote ..	3·871 or 2·323
M.R.Ry. Subba Rao's see-saw water-lift ..	3·511

In the first two cases, the lifts are worked by pure draught on a horizontal plane and the result shows that the animals were doing about the work they ought to, in the third case the draught is down an inclined plane and the number of foot-tons of work done by the bullocks includes that due to raising themselves vertically through a height equal to that which they descended down the plane and is consequently much greater, but, if only the work done on the rope be taken into account, the foot-tons of work per pound weight would be reduced to 2·323. In the fourth case, the animal exerts no draught whatever and simply does work by walking up an inclined plane, and in consequence much of the energy expended in muscular action becomes available and the amount of work done per pound weight is greatly increased.

Examining the results in this way, the conclusion is confirmed that the most efficient way of utilizing animal power is to make the animal raise himself against the action of gravity and then in some way, such as that adopted by M.R.Ry. Subba Rao, convert the potential energy stored in the animal's body into work. The disadvantages of this method are purely mechanical and due to the necessarily cumbrous apparatus which must be used.

MADRAS, A. C.
17*th January* 1896.

NOTICE.

It has been decided not to issue the illustrations to which allusion is made in the text.

(Implement and Machinery Series, No. 3.)

THE

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1896—No. 17.

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AGRICULTURAL IMPLEMENTS.

(WATER-LIFTS)

(*Dictionary of Economic Products, Vol. I, A. 647.*)

EXPERIMENTS ON WATER-LIFTS.

By A. CHATTERTON, ESQ., B.Sc.

With reference to G O., Mis. No. 725, Rev., dated 16th February 1895, the Committee thereby appointed begs to submit the following report.

Mr. E. W. Stoney's lift with automatic tilting buckets.
Sultan Mohidin Sahib's water-lift.
M R Ry. C. K. Subba Rao's see-saw water-lift.

The instructions to the Committee were to report, after trial, on the relative merits of the three water-lifts noted on the margin. From the correspondence recorded in Board's Proceedings, Nos. 1178, 1398, 1788 and 2419, Mis., of 1895, Government will have learnt that Messrs. Sultan and Co. were not prepared to submit to the Committee for trial the "Sultan" water-lift patented by Sultan Mohidin Sahib, and the Committee accordingly did not test that lift. Mr. Stoney's water-lift was not ready for experiment at Saidapet until the middle of July, and on that date the see-saw lift, which M.R.Ry. Subba Rao voluntarily undertook to erect there at his own cost, was still unfinished. To avoid further delay, the Committee therefore proceeded to experiment on one of M.R.Ry. Subba Rao's lifts that had been erected at the Luz. Shortly before the actual trials took place, M.R.Ry. C. K. Subba Rao constructed an improved single mhote lift which he has devised, and this was also tested.

The Committee submits a report (with drawings of the lifts) prepared by Mr. A. Chatterton, which is so complete that it leaves little room for further remark.

The essential novelty of Mr. Stoney's lift lies in the automatic tilting iron bucket. The trials showed that this bucket works very efficiently. It is as suitable for use with the ordinary country lift as with a whim, and, as there is none of the leakage which is inevitable

with buckets made of leather, or fitted with valves, its superiority over leather or valve buckets becomes greater as the depth of the well increases. The lift taken as a whole also gave good results on trial, and might have been worked with a much smaller bullock.

M.R.Ry. Subba Rao's see-saw lift can be used with any bucket The iron bucket with a leather discharging trunk used during the experiment was not in good order. This lift also gave remarkably good results, but, as pointed out by Mr. Chatterton, the design cannot as yet be regarded as having reached its limit of perfectibility. Its merits are described in Mr. Chatterton's note, and mainly lie in utilising the force exerted by the bullock and driver in ascending an inclined plane It is in its essence a picottah in which one bullock, by its mere weight, does the work of several men. As the length of the oscillating platform must be limited by considerations of weight and cost, the design is not adapted for wells in which the water is more than 30 feet below the ground level.

Regarding both the above lifts, the Committee is of opinion that whilst they are much more efficient than the single mhote, and whilst they, in common with the double mhote, cause much less wear and tear on the bullocks employed, it would require more skill to erect and keep them in working order than is usually available in up-country villages, and that to enable the village blacksmiths to do this work, their training would have to be improved. As to the cost of the lifts, it is not possible to give any definite information; but the Committee consider that either might be put up for about Rs. 150, though the charges for Subba Rao's lift would vary greatly according to the materials locally available. Where palmyrahs are plentiful and cheap it might be possible to design and erect a see-saw platform at a cost well within the means of the ordinary ryot. It must be remembered that the ordinary single mhote, as used in Southern India, does not cost more than about Rs. 20.

As regards M.R.Ry. Subba Rao's new lift, wherein the action is the same as in the single mhote, except that the weight of the bucket is counterbalanced, and the bullocks are enabled to reverse at the end of the incline and walk up the slope, the Committee is of opinion that, where cattle labour is scarce, the contrivance should prove most valuable, being well within the means of the ryot, and within the capacity of the village artisans to erect. The Committee considers that Mr. Subba Rao is deserving of great commendation for the ingenuity and perseverance displayed in his efforts to devise an improved water-lift, and deems it a matter for regret that he is under the disadvantage of not having been trained as a mechanical engineer.

(Signed) H. M. WINTERBOTHAM.
(„) C. BENSON, M.R.A.C.
MADRAS, („) A. CHATTERTON, B.Sc.
22nd August 1895.

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Mr. CHATTERTON'S REPORT.

Three water-lifts were submitted to the Committee for trial: (1) a water-lift with self-tilting buckets by Mr. E. W Stoney of the Madras Railway, (2) an improved single mhote by M.R.Ry. Subba Rao, (3) a water-lift worked by an oscillating platform also by M R.Ry. Subba Rao. The Committee also experimented on the old double mhote erected at the Saidapet farm about twenty years ago, and which, in its present condition, represents the average of high-class water-lifts working in southern India. Hitherto no reliable experiments have been made on the efficiency of the various forms of water-lift worked by animal power which are in common use, and the Committee, in carrying out the investigations necessary to form an opinion on the matter submitted to them by Government, determined to remedy this as far as possible, recognizing that the only way in which improvement can be effected is by the compilation of accurate data regarding the different types of water-lifts already in existence The experiments conducted by the Committee had the following objects in view :—

The determination of—

(1) the quantity of water and the effective height it was lifted in a given time by bullocks of known weight, and working in a way that did not unduly fatigue them ;

(2) the quantity of work actually obtained from the animals in the same time ;

(3) the quantity of work which might have been obtained from the animals in the same time had the working of the lifts been continuous.

The first quantity divided by the second gives the mechanical efficiency of the water-lift, and the first quantity divided by the third gives its absolute efficiency as a machine for utilizing animal power in a given way.

(4) The quantity of work represented in the water lifted per hour divided by the weight of the bullocks in lb.

This yields a constant which, on the assumption that the animals employed in working the various lifts are all equally strained, enables a comparison to be made between very different types of water-lift and very different methods of applying animal power. In some lifts only the draught of the animals is utilized, in others, as for instance, the ordinary single mhote, both draught and weight are utilized, whilst in a third class only the animals' weight is made use of as, in Mr. Subba Rao's oscillating platform, and between such very different methods the constants yielded by (4) seems to be the best method of making comparisons of the actual value of different machines for lifting water. It must be remembered that though the mechanical efficiency of a water-lift may be high, yet the mode of getting work out of the animals employed may be bad, and the actual value of the water-lift therefore small. The value of the constants yielded by (4) depends on the assumption that the strength of animals is proportional to their weight, which is probably roughly true for animals in good working condition

and in the prime of life, and on the accuracy with which it is possible to estimate whether two animals working in different ways are exerting themselves to their full working capacity. The figures therefore obtained are only to be taken as offering a rough method of comparing the different lifts and as a guide in estimating their probable value as machines for lifting water.

Methods of measurement employed in the experiments.—All weights were determined and draughts measured with a Salter's spring balance, recording to 500 lb. and indicating differences of half a pound, which, previous to the commencement of the experiments, was tested with dead weights in the College of Engineering and found to be accurate. The quantities of water raised were measured in the case of Stoney's lift by counting the number of buckets emptied and multiplying that number by the contents of one bucket. As there was no leakage, it was found that each bucket came up with practically the same quantity of water in it, and by weighing that quantity it was possible to obtain a very accurate determination of the total quantity of water raised. In the other lifts, iron buckets with leather discharging trunks were used, and, as they all leaked to a certain extent, the quantity of water raised was determined by multiplying the total number of lifts by the average quantity lifted in a single bucket obtained by taking the mean of a number of buckets measured in an iron tank capable of holding about 250 gallons. Speeds and times were measured with a stop-watch recording fifths of seconds. Measurements of draught and friction were made by inserting the spring balance, which was used as a dynamometer, in the line of action of the forces exerted by the bullocks and employing a number of coolies to work the lifts in their place. In machines like water-lifts, which, of necessity, are somewhat roughly constructed, no great amount of labour is expended on fitting the moving parts together, and in consequence the working is not perfectly smooth and the friction varies considerably in a single operation of the machine. The measurement of draught is therefore not very easy, and the results given below are, in every case, the mean values obtained from a large number of observations.

Stoney's water-lift.—The principal feature in this lift (Plates II and III) is the employment of buckets of wrought iron suspended in a stirrup by two adjustable pivots attached to the bucket very slightly above the centre of gravity of the bucket when full of water. The mouth of the bucket is inclined as shown in the drawing, and the lower ends of the stirrup are turned outwards and encircle steel wires which are suspended in the well from screwed eye-bolts attached to the framing above. The wires are fastened by some convenient means to the bottom of the well and act as guides to the bucket, ascending and descending, and prevent it from either turning round or swaying to and fro and thus striking either the sides of the well or the second bucket. On the bucket being lowered into the water, it turns horizontal and rapidly fills with water, and on being drawn up assumes a vertical position and rises steadily out of the water till the discharging level is reached, when the upper side of the inclined mouth comes into contact with an iron bar fixed

across the framing of the lift, and the stirrup, continuing its upward motion, causes the bucket to revolve about the point of contact of the bucket with the iron rod, and thus discharge its contents into the delivery trough. The lift, as arranged at Saidapet (*vide* Plate I) during the trials conducted by the Committee, was worked by carrying the ropes which hold the buckets over guide pulleys to a whim turned by either a pair of bullocks or a single bullock. Two buckets were attached and the ropes arranged, so that as one bucket ascended the other descended and the dead weight of the buckets was balanced. The whim consisted of a drum built of wood and carried by an iron spindle on the top of a post firmly built into the ground. The bullocks worked at the end of a long arm, the circumference swept out by which was 3·85 times the circumference of the drum. The whim is worked alternately in one direction and the other, the cattle being made to turn round whilst the bucket is discharging its contents. The lift was provided with two sets of buckets of a nominal capacity of 30 and 25 gallons respectively. In the following table is exhibited the data regarding their capacity :—

TABLE I.

		Weight empty	Weight of water when full.	Weight of water delivered by buckets
		LB.	LB	LB
30 gallon buckets .	No 1	101	296	280
	No 2	98	295	280
25 gallon buckets ...	No 1 ..	68	245	230
	No. 2 ...	67	237	230

The capacity of the lift was tested by working it with a single Nellore bullock weighing 1,146 lb. on three different days, but, owing to insufficiency of water in the well no test could be continued for more than 2 hours 42 minutes. In table II the results obtained are shown :

TABLE II.

Date.	Time started.	Time stopped.	Number of buckets raised.		Lift at beginning.	Lift at end.	Mean Lift	Gallons raised per hour.	Foot pound of useful work done
16-7-95.	8-37	9-37	88	30-gal. buckets.	22' 0"		22·625	2,594	586,900
	9-37	10-07	51		...	23' 3"		...	.
	2-4	3-4	91		21' 10½"		...		...
	3-4	4-4	86			..	23·24	2,469	575,500
	4-4	4-46	63		.	23' 6"	..		..
17-7-95.	2-0	3-0	85		22' 2"	.	22·87	2,391	546,900
	3-0	3-51	73		...	23' 6½"	...	..	..
18-7-95.	2-29	4-29	167	25-gal. buckets.	22' 2"		22·75	1,886	429,060
	4-20	5-29	79			23' 4"	...		...

The results obtained with the 25-gallon buckets compare unfavourably with those obtained with the 30-gallon buckets as the animal employed was evidently not doing as much work as he might easily have done. His natural gait determines the number of lifts he can make per hour and the number is practically the same with the smaller as with the larger buckets. He could easily lift the 30 gallon buckets; a smaller animal should therefore have been employed to work the 25 gallon buckets.

The following observations were made on the draught required to work the lift, and the friction when working. The length of rope to go once round the drum was 19·33′ and the circumference of the path in which the bullock walked 74·33′ so that the velocity ratio was 3·846 With both buckets empty, it was found that a weight of 30 lb. placed in one bucket was sufficient to overcome the friction and cause that bucket to descend and the other to ascend at a uniform velocity. With 28 gallons of water in each bucket, 52·5 lb. was found necessary to set the whole water-lift in motion at a uniform speed. To work the lift at about the speed at which it was worked by the single bullock, it was found necessary to exert a pull of 92 lb. at the end of the lever attached to the whim, whilst a pull of 87 lb. was found sufficient to just set the buckets in motion. With one bucket full and the other empty, it was necessary to exert a pull of 57 lb. at the end of the lever arm to prevent the full bucket from falling back into the well. Half the difference between 87 and 57, or 15 lb., represents the pull that is required to just overcome the friction of the mechanism. The mean between 87 and 57, or 72 lb. represents the pull which must be exerted to raise a full bucket neglecting friction, and this quantity multiplied by 3·85 should be equal to the weight of water in the bucket, viz., 280 lb.; actually it is equal to 277 which is a very accurate result considering the roughness with which the apparatus is constructed. From these figures it is easy to deduce that the mechanical efficiency of the lift when just moving is 83·6 per cent. and at the ordinary working speed 79 per cent. It was found that the speed at which the bullock walked when exerting a draught of 92 lb. was, as the mean of a number of observations, 3·646 feet per second and that in 162 minutes he raised 240 buckets of water, lifting each bucket 23 feet. Walking at this speed without stopping, which, without doubt, the animal could have easily done, he could have lifted 401 buckets, so that he was only usefully employed for 59·7 per cent. of the time. The absolute efficiency of the lift was therefore 0·79 × 59·7 per cent. or 47·2 per cent. This calculation neglects to take into account the extra pull which is necessary to tilt the bucket to make it discharge, which was found to amount to 122 lb. and which was exerted through about 3 feet. This quantity would only affect the result very slightly and the decrease in efficiency would diminish, as the height to which the water has to be raised increases.

Improved Single Mhote of M.R.Ry. Subba Rao.—The improvement (Plate IV) on the ordinary single mhote is effected by attaching a rope to the draught rope and carrying it on to the large drum of a kind of windlass erected at the end of the inclined plane and at a consider-

able height above the level of the end of the run. Cords wound round two smaller drums, one on each side of the large drum, carry weights, which it was found almost balanced the weight of the empty bucket, so that at the end of a lift, as soon as the bucket was empty, the draught rope automatically rose in the air and the bullocks were able to turn round and walk up the inclined plane in a natural easy manner instead of being forced backwards as is the common plan. The improvement effected is undoubtedly a very great one, as not only is the weight of the empty bucket practically balanced, but the animals are also spared the cramped and unnatural backward walk up a steep incline which probably tires them more than their exertions in drawing the bucket out of the well. The experiments made on this lift were not very extensive, but the following results were obtained and are worthy of record. The mhote was worked by two bullocks weighing 732 lb. and 616 lb. respectively, or in the aggregate 1,348 lb. The bucket, which was of iron and fitted with a leathern discharging trunk, weighed 43 lb and when full held 31 gallons of water, but the mean quantity lifted, as measured into a tank, was 24·2 gallons per lift, the rest being spilt or lost by leakage. With the bullocks employed, the rate of working was 90 lifts per hour, and the height of the lift being 23 feet, the total quantity of work usefully done amounted to 500,940 ft.-lb. per hour The draught exerted by the bullocks down the inclined plane was found to be 383 lb. The useful work done in a single lift was 24·2 × 10 × 23 or 5,570 ft.-lb., whilst the bullocks exerted a pull of 383 lb. through 25½ feet, the bucket having to be raised an extra 2½ feet to enable it to discharge its contents, and the work done is equal to 9,760 ft.-lb. The bullocks then had to return up a gradient of 1 in 5·28 feet, in doing which they expended 6,510 ft.-lb. of energy in lifting their own weight against the action of gravity. The total amount of work done by them in a single lift was therefore 16,270 ft.-lb. and the useful outturn 5,570 ft.-lb., so that the efficiency of this method of lifting water is not greater than 34·3 per cent. As compared with the ordinary single mhote, the great advantage which this lift possesses is that it allows the bullocks to turn round at the bottom of the inclined plane and ascend walking forwards instead of backwards, an advantage which it would be difficult to express numerically, but the balancing of the bucket diminishes the draught by about 40 lb. and increases the efficiency of the lift by about 6·3 per cent., not perhaps a very large amount, but still by no means a negligible quantity.

See-saw water-lift of M.R.Ry. Subba Rao.—An attempt was made to erect one of these water-lifts at Saidapet, but it was not ready at the time of the Committee's trials, and in its place Mr. Subba Row asked the Committee to report on a lift which had been in use for some months in a garden in the Lus. In this form of water-lift (Plate V), the bullock is made to walk along a platform supported on a roller, and by his weight it is caused to oscillate up and down. Two ropes are attached to one end of the platform and wound round two small drums forming part of a species of windlass, round the large drum of which a rope working an ordinary single mhote is passed. The platform is not supported

in the middle, but at some distance therefrom, so that the working end of the platform greatly preponderates and the bullock has to walk to the free end of the platform to tilt the longer segment up and lower the bucket into the well. The platform is 24 feet long and the supporting roller is fixed 15 feet 3¾ inches from the working end. It was not possible to weigh the platform, and calculations of its weight based on the quantity of timber used in it can only be approximate. It was however carefully measured up, and assuming that the teakwood, of which it was constructed, weighed 45 lb. per cubic foot, the weights of the two sections are 1,450 lb. and 850 lb. To diminish the shock when the free end falls and the bucket is lowered into the water, 230 lb. of iron rails are fastened underneath the platform by a short chain, so that just before this end of the platform reaches its lowest position, the rails rest on the ground and their weight ceases to act, and the platform comes to rest more gently than would be case if the velocity of descent continued to accelerate to the very end. The ropes from the platform were wound round drums, the circumference of which was 3 feet 2¼ inches as measured by unwinding one coil of the rope, and the mhote rope was worked from a drum 7 feet 10 inches in circumference, so that the motion of the working end of the platform was multiplied 2·443 times. With the bucket empty and the platform horizontal, the load at the free end could be varied from 160 lb. to 362 lb. without disturbing the equilibrium, whilst with a load of 247 lb. in the bucket equal to 24 7 gallons of water, the platform remained horizontal, though the load at the working end varied between 584 lb. and 275 lb. Taking the mean between the two extreme values to be the actual weight required to balance the platform, it is possible by taking moments about the centre to determine the only force acting on the platform which was not measured, viz., the weight of the empty bucket and ropes acting with a leverage of 2·443 to 1. With the bucket unloaded, the weight works out as 65·4 lb. and when loaded, 62 lb.—a remarkably close agreement. The lift was worked during the trial by a bullock weighing 700 lb. and a man weighing 117 lb. The rate of working was 81 lifts per hour from a well 18′ 1″ deep. The average quantity of water brought up by the bucket, as measured into a tank, was 23·5 gallons, and the useful work done per hour amounted to 344,210 ft.-lb. The bullock and the man together were much heavier than was really necessary, and they did not use the full length of the platform, so that it is difficult to estimate the work done by them in working the lift, but the mechanical efficiency of the lift on the day of the trial can be ascertained by multiplying the fall of the front end of the platform by the force required to set it in steady motion when lifting a bucket full of water. The total height the bucket had to rise to discharge its contents was 22 feet, and the end of the platform therefore fell 9 feet and the work done was $584 \times 9 = 5{,}256$ ft.-lb. To raise the platform back to its initial position, the free end then falls 5·18 feet and the load on it is 362 lb. and the work done is equal to 1,875 lb. The total work therefore done in a single lift is 7,131 ft.-lb., and the useful work given to the water is 4,245 ft.-lb., so that the mechanical

Water-Lifts (*A. Chatterton*).

efficiency when just working is 59·6 per cent.; at the normal rate of working it is much lower, probably not more than 50 per cent.

The double mhote at Saidapet.—This water-lift is described in the *Saidapet Farm Records* by Mr. C. Benson, and though not in very common use in the Presidency is sufficiently well known to need no description. The details and general arrangement are shown in Plates I and VI. This lift was worked by the bullock that was employed in the experiments on Mr. Stoney's water-lift, and as the draught was practically the same in both lifts, the results are strictly comparable The buckets were of iron with leather discharging trunks and were in good order and discharged an average of 28 gallons per bucket as measured into a tank The trial lasted 3 hours, and in that time 200 buckets of water were raised The mean lift was 22·125 feet and the useful work done per hour was 413,000 ft.-lb. The circumference of the drum of the whim was 12 feet 11½ inches, and the circumference of the circle in which the bullock walked was 60 feet 9 inches, so that the velocity ratio was 4 67 The pull on the dynamometer at the ordinary speed of working was 90 lb. and the pull to just prevent a full bucket descending 59 lb. and the pull to just raise a full bucket 81 lb The mean between these last two quantities, 70 lb, is the force at the end of the lever arm required to balance a full bucket of water when friction is eliminated. Multiplying by the mechanical advantage, the unbalanced weight is 327 lb—a result probably not very much in error, as the water in the bucket weighed about 300 lb. The mechanical efficiency of the lift just moving is therefore 74 per cent. and working at its normal speed 66·6 per cent. The lifts averaged 1 111 per minute, and the animal was therefore usefully employed for 52·5 per cent. of the time, and the absolute efficiency of the lift as a machine for utilizing the energy of the bullock is 0·66 × 52·5 or 35 per cent

Summary of the results.—To facilitate comparison the results given above are collected in the table below :—

TABLE III.

	Mr. Stoney's water-lift	Double mhote at Saidapet.	M.R.Ry Subba Rao's improved single mhote	M.R.Ry Subba Rao's see-saw water-lift.
Useful work in ft.-lb. per hour, A	571,500	413,000	500,940	344,210
Weight of animals in lb, B	1,146	1,146	1,348	700
$\frac{A}{B} = C$ ..	498	360	371	492
Mechanical efficiency just moving	83 6°/ₒ	74°/ₒ		59·6°/ₒ
Mechanical efficiency at working speed	79°/ₒ	66·6°/ₒ	34·25°/ₒ	
Absolute efficiency ..	47·2°/ₒ	35°/ₒ		

Agricultural Implements.

Experiments on

Owing to the entire absence of leakage and the superior design of all the mechanical details, Mr. Stoney's water-lift has the highest mechanical efficiency and the highest absolute efficiency. The simple arrangement by which the bullock is yoked to the lever arm which is also used in the Saidapet double mhote and the rapidity with which the self-tilting buckets discharge their contents are the principal factors which contribute to the attainment of the high time efficiency. The value of the constant C is practically the same as that obtained with the see-saw water-lift of M.R.Ry. Subba Rao; but it is possible that the bullock employed might have been able to work with buckets holding more than 30 gallons of water, say 35 gallons, in which case the value of C would have been materially greater; but it was a point the Committee were unable to decide as no larger buckets were available It is not likely that any great improvement can be made in the design of the lift, though prolonged experience of it at work will reveal the weak points, and the details can be simplified The framing supporting the buckets was in the lift at Saidapet unnecessarily complex, and Mr Stoney has prepared designs of very much simpler forms of framing, which can be used for lifts permanently erected over any well The buckets might probably be made a little lighter, and the lip which comes in contact with the tilting bar requires thickening to prevent the burring of the edge which at present takes place Owing to the employment of a single lever arm, there is a certain amount of bending stress on the spindle which carries the drum, and experience will probably show that the wooden post and spindle are scarcely stout enough. The arrangement for adjusting the length of rope to the depth of water in the well is very neat and simple From a ryot's point of view, the use of a number of nuts and bolts is an objection which is likely to be urged, but which may be partly met by designing the details, so that only one size of nut and bolt is used throughout the machine The self-tilting buckets also require to be very carefully hung from their stirrups, and though the extra pull required to overturn them is diminished by hanging them, so that the equilibrium is nearly unstable, yet experience will probably show that in the hands of the ryot the lift will work more satisfactorily if the equilibrium is a little more stable. The tendency to spill just as the bucket comes out of the water will then be diminished, and the work on the guide wires to keep the buckets steady will be less. By making the ratio of the diameter to the depth of the bucket greater, the effort required to tilt them would diminish and they would discharge even faster than they do now, but experience with buckets of different proportions will alone show whether any appreciable improvement can be effected in this direction. The guide wires render it practicable to employ iron buckets in rocky wells, as there is no fear of the bucket being damaged against the side of the well, and by covering the bottom of the well, with a foot of sand or by placing a sand bag at the bottom of the well, the danger of the buckets being destroyed by rough usage is greatly decreased From a mechanical point of view the whim would be improved by the introduction of an automatic reversing motion to obviate the necessity of turning the animals at the end

of each lift, but it would not compensate the ryot for the extra cost and extra complication this change would involve. The whim can only be satisfactorily worked by a single bullock, as the diameter of the circle in which they walk is so small that with two animals the inside one always works at a great disadvantage, and to increase the length of the lever arm is to introduce other disadvantages. The power of the animal is entirely utilized through his ability to exert a draught, and it is a well-known fact that walking straight forward the power to draw is considerably greater than when walking in a circle. It is commonly assumed that the pull exerted by a horse walking round a circle of 25 feet diameter is only 60 per cent of that which he can exert when walking in a straight line, but the data from which this result was deduced are not available. Probably with bullocks the loss of power does not exceed 20 per cent., as they are smaller animals with shorter legs, but though uncertainty may exist as to the amount of the loss, there is no doubt that there is a loss and that it is a disadvantage inherent in all water-lifts which employ whims.

The single mhote, although very largely employed, is a very inefficient machine, and its prolonged working involves a very great strain on the cattle. The simplicity of the machine, however, compensates for its inefficiency, and the merit of M.R.Ry. Subba Rao's improvements chiefly lies in the fact that, without introducing any expensive or complicated additions, he has balanced the weight of the empty bucket and rendered it possible to turn the bullocks at the end of each run, so that they may walk up the incline in a more comfortable and expeditious manner than in the original lift. The additional gear involved can be fitted to any existing single mhote, and it is probable that, if it becomes known to owners of single mhotes, it will be largely used.

M.R.Ry. Subba Rao's see-saw or oscillating water-lift can be worked with any type of bucket, and it was undoubtedly not being worked to advantage when tried by the Committee as the bucket was an iron one of the old-fashioned mhote type and was not nearly as large as it might have been. The design was far from perfect and the mechanical efficiency was very low, yet the constant C obtained by dividing the useful work done in ft.-lb. per hour by the weight of the animal is nearly as high as for Mr. Stoney's water-lift. With a better type of bucket and one of larger capacity, the constant would certainly have been much higher. In its present condition, it would be useless to criticize the details of the lift which requires to be put into the hands of a good mechanical engineer to bring out the many merits which this method of applying animal power to the performance of useful work possesses. The animal does work by raising his own weight against the action of gravity, and without going into a lengthy discussion of the various methods of getting work out of animals, it may be asserted without fear of contradiction, that an animal can do more work in a given time with the same amount of exertion when that work consists in storing potential energy in his own body than in any other way. The difficulty is to devise a simple and cheap means, whereby that potential energy can be converted into useful work, and it would appear that

Experiments on

M.R.Ry. Subba Rao has probably arrived at a practical solution of the problem. In principle, the working of the lift in no way differs from that of the picottah, and not one of the least of the advantages which it possesses is that it is capable of being worked by coolies and in a very efficient manner should cattle from any cause not be available to work it. With every water-lift there must be a man employed to drive the bullocks, and in other forms of motor, this work, whatever it may amount to, is wasted, but in this form of motor, the work done by the man is usefully employed. It is partly due to this that the constant C has such a high value. Below are given two equations showing the forces acting on the platform when it is in horizontal equilibrium (1) when the bucket is empty and the animal is at the free end, (2) when the bucket is full and the animal is at the working end. No account is taken of the friction which necessarily exists and which will consequently diminish the quantity of water which can be lifted by an animal of a certain weight:—

Let x = length of long arm of platform.
x^1 = distance of centre of gravity of bullock from fulcrum along long arm.
y = length of short arm of platform.
y^1 = distance of centre of gravity of bullock from fulcrum along short arm.
W_1 = weight of long arm.
W_2 = weight of short arm.
A_1 = weight of bucket when empty.
A_2 = weight of the water when the bucket is full.
B = weight of bullock.
V = velocity ratio of windlass.

Then when the bucket is empty—

$$(1)\quad W_1\left(\frac{x}{2}\right) = W_2\left(\frac{y}{2}\right) + By^1 + VA_1 x.$$

$$(2)\quad W_1\left(\frac{x}{2}\right) + Bx^1 = W_2\left(\frac{y}{2}\right) + (A_1 + A_2)\,Vx.$$

Subtracting (1) from (2) we get

$$B\,(x^1 + y^1) = VA_2\,x,$$

$$\text{that is, } A_2 = \frac{B}{V}\left(\frac{x^1 + y^1}{x}\right).$$

The preponderance of the working end of the lift should, therefore, be such that it is necessary for the bullock to go to the free end to cause it to descend, and the weight of water which should be drawn up each time should be equal to $\frac{B}{V}\left(\frac{x^1 + y^1}{x}\right)$ multiplied by a coefficient which will be less than unity in proportion to the percentage of power wasted in friction. In the lift designed by M.R.Ry. Subba Rao, the preponderance of the working arm was not sufficient, as it required only 362 lb. at the free end to cause it to ascend, whilst it required 584 lb. at the working end to set it in downward motion. The bullock and the man working the platform cannot, of course, put their whole weight on the extreme ends of the platform, but it is possible for their centres of gravity to

approach within 2 feet of the ends which would make the values of $x^1 + y^1$, 13 feet and 7 feet respectively, and the value of $\frac{B}{V}\left(\frac{x^1 + y^1}{x}\right)$ with a bullock weighing 700 lb. and a man 117 lb. would be 445 lb. equal to 44½ gallons of water. Allowing for obliquity of action at the beginning of each oscillation and for friction by the use of a coefficient of 0·75, which, with a properly-designed lift, should be attainable, the quantity of water lifted might reach 33 gallons, whereas it was only 23·5 gallons With a heavier load, the lift would have worked better, and though possibly the time of ascent of the bucket from the well would be slightly longer, the effect on the total number of lifts per hour would be almost inappreciable, as the time efficiency of this lift depends mainly on the turning of the bullock at the ends.

A question of some importance in connection with this oscillating platform is the gradient which it assumes when in the extreme positions In the lift in the Luz, the length of the platform was 24 feet and the rise and fall of the working end 9 feet, so that the slope which the animal had to walk up was 1 in 2·66 With a long platform, the period of oscillation will be slow, and it will therefore work more steadily than with a short platform, the gradient will be less and the animal will be able to ascend it easily, but the greater the length, the heavier the platform becomes and the more expensive it will be. There will be some particular gradient on which the animal can do most work, which can only be determined by experiment, and as this will be largely influenced by the nature of the surface the animal has to walk on, attention should be directed to this point. In the matter of gradient, the lift at the Luz appeared to be satisfactory, but the nature of the foot-hold seemed to leave room for improvement.

The initial cost of setting up a water-lift is a point of supreme importance to the ryot, and in this respect the improved water-lifts submitted to the Committee compare unfavourably with those in use at the present time. This is a difficulty which cannot be got over, and if the ryot wants, and there is no doubt that in many districts he does, a better machine for lifting water from wells he will have to face a greater capital outlay. During the greater part of the irrigation season, there are, in many places, a large number of unemployed cattle available for working water-lifts, and in such places the introduction of improved water-lifts is likely to make slow progress, but where more water is wanted than can be obtained by existing methods, experience of sugar mills and iron ploughs shows that the ryot is not slow to adopt an innovation if he finds that he really benefits thereby. Between the two water-lifts submitted to the Committee, there is not likely to be any great difference in price, but what difference there is will probably be found to be in favour of Mr. Stoney's invention. Next to initial outlay comes the question of maintenance and repairs, and on this point it is, without prolonged experience of their working, difficult to express any decided opinion. To erect them and keep them in working order requires more skill than is usually available in the villages, and they can only come into extensive use by improving the skill of the ordinary

country blacksmiths. To do this will no doubt be a far from easy task, but it is one that might well be taken up by the technical side of the Educational Department. If a demand for skilled fitters and smiths arises, it should be possible for the various technical and industrial schools in the Presidency to meet it.

MADRAS, (Signed) A. CHATTERTON, B.Sc.
21*st August* 1895.

ADDENDUM.

Since writing the above report I have been informed by Mr. W. Keess, the Principal of the Agricultural College, Saidapet, that the assumption, that the amount of work which draught animals can do is approximately proportional to their weight, is one which is generally accepted by agricultural authorities He also informs me that draught animals, working steadily an average of 8 hours a day, can do 2 foot-tons of work per pound of their weight per day. It must of course be clearly understood, that such work is entirely external and is not part of the energy expended in the muscular action In table III of the report, a summary of the experimental results is given from which it is easy to calculate the number of foot-tons of work done per pound weight of the animals employed in working the four lifts upon which experiments were made This calculation has been made with the following result:—

	Foot-tons of work per lb. weight.
Mr. Stoney's water-lift	2·253
Double mhote at Saidapet	1·930
M.R.Ry. Subba Rao's improved single mhote	3·871 or 2·323
M.R.Ry. Subba Rao's see-saw water-lift	3·511

In the first two cases, the lifts are worked by pure draught on a horizontal plane and the result shows that the animals were doing about the work they ought to, in the third case the draught is down an inclined plane and the number of foot-tons of work done by the bullocks includes that due to raising themselves vertically through a height equal to that which they descended down the plane and is consequently much greater, but, if only the work done on the rope be taken into account, the foot-tons of work per pound weight would be reduced to 2·323. In the fourth case, the animal exerts no draught whatever and simply does work by walking up an inclined plane, and in consequence much of the energy expended in muscular action becomes available and the amount of work done per pound weight is greatly increased.

Examining the results in this way, the conclusion is confirmed that the most efficient way of utilizing animal power is to make the animal raise himself against the action of gravity and then in some way, such as that adopted by M.R.Ry. Subba Rao, convert the potential energy stored in the animal's body into work. The disadvantages of this method are purely mechanical and due to the necessarily cumbrous apparatus which must be used.

MADRAS,
17*th January* 1896.

A. C.

(Agricultural Series, No. 17.)

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AGRICULTURAL IMPROVEMENTS.

[*Dictionary of Economic Products, Vol. I.*, A. 647a.]

THE MEERUT DEMONSTRATION FARM.

Note by DR. J. W. LEATHER, *Agricultural Chemist to the Government of India.*

I visited this farm on January 4th, 1895, in company with Mr. Wyer, the Collector.

2. The most important of the experiments consisted in testing different manures on the wheat crop and in demonstrating the comparative value of the iron and local (wooden) ploughs. It is proposed to keep a stud-bull and a ram with a small flock of sheep at the farm. The greater part of the farm is worked for profit. The farm has had a somewhat chequered existence and has not been carried on, so far as I can learn, with any very definite aim. Mr Wyer has now taken the matter up and I feel sure that good results may be anticipated. I notice that Mr. Miller, Director of Land Records and Agriculture, has recommended that it should really play the part of a Demonstration Farm, by which is meant the demonstration at Meerut of what has been found useful elsewhere. In this opinion I quite agree, and if the work be planned to this end it should prove a valuable institution.

I will now mention some one or two matters which, it occurs to me, might be put into practice with a view of demonstrating their value to the cultivators.

Storing of Manure.

3. *Conservation of Cattle Dung and Farm-yard Manure.*—There has, generally speaking, been considerable laxity at Experimental Farms in India as to the manner of keeping cattle dung and such other refuse as may go to form (with the dung) "Farm-yard Manure." There is perhaps no more important lesson to be learned by the Indian ryot than how to take care of his manure properly.

How often, for instance, does one find in the villages the little manure, which the people have for their fields, scattered about in little heaps exposed to sun and rain, or in other cases put on the banks of the village pond. Now there is consequently no more important lesson to be taught to the cultivators at our farms than a good and easy method of storing this material properly. In the cattle sheds at the farm I would recommend that a little bedding of either refuse straw or grass or even dry leaves be used, and when this with the dung is removed, it should all be kept in a pit. These pits should be about 3 or 4 feet deep and should have a light thatch roof supported by bamboos. I have found at all the farms that this farm-yard manure in India requires a little water to be

thrown on it in the hot weather, for where this is not done the manure becomes mouldy and does not ferment as it should do. How much water should be given will depend entirely on the locality and must be guaged by the Superintendent. He needs only to have a hole dug into the mass in order to see the condition inside and must use his judgment It may even be desirable to remove the thatch altogether in the rains. This point can, however, be only determined by experience.

I would recommend that the careful treatment of cattle manure with other refuse be considered an essential part of the farm work. It is indeed a most valuable thing to demonstrate to the cultivators.

Manure Experiments.

4. *Manures.*—Regarding the manure experiments with wheat I think these might continue. There are eight plots and if they are carried on carefully and continuously, they may eventually form a check on some experiments of a similar nature which have been in progress now for some 13 years at the Cawnpur Experimental Farm. I refer to the Rabi Standard Series. I would advise no alteration in these plots and that the weighments of both the manures and the wheat crop should be carried out with the utmost care, for naturally much depends on the accuracy with which this is done.

Sewage water.

5. *Sewage.*—A suggestion has been made by Mr. Wyer to test the value of the sewage water, which passes near the farm on its way to the river, for manurial purposes. I consider the suggestion a most valuable one and well worth carrying out. It might be tried on several crops, such as wheat, sugarcane, maize, *juar*.

Three plots might, in every case, be usefully employed; on one no manure should be used, on a second one an ordinary (but *weighed*) amount of cowdung, or farm-yard manure, say, 100 maunds per acre, whilst on the third the sewage should be run. The sewage would also at the same time *irrigate* the plot, and in order to equalise this, the other two plots should be irrigated with common water.

Trenching of Night-soil.

6. *Night-soil.*—This is trenched by the Municipality, and I doubt very much if night-soil could be more perfectly disposed of than in the manner in which I saw it being trenched at Meerut. I came on the land immediately after two carts had been emptied and the trenches filled again, and I can say, without any exaggeration, that there was no smell. It might possibly be worth while to try at Meerut the method now being adopted at Allahabad which may be described as a very shallow method of trenching. I quote here the description of the method which is given in the Appendix of Report on the Allahabad Grass Farm for 1892-93. "According to the regulation the trenches are to be dug 1' wide 6" deep, of which 3" are to be filled in with filth and 3" with pure earth on top. From experience, however, I can say that the beldars usually dig the trenches much deeper, and to save themselves trouble fill the trenches with filth, and when earth is thrown on it some comes to the top and causes a smell. At the Allahabad Grass Farm the following system devised by Conductor Meagher has been found to answer best. For the contents of each filth cart, a rectangular space 4'×5 is taken and the top soil scraped off to the edges to a depth of about 3". The soil at the bottom of the space is then loosened and pulverised to a depth of 6" or 7". The shallow trench having been thus prepared, the contents of the filth carts (Cowley pattern) are tipped into it. If the bottom soil has been well pulverized, the filth portion soaks into it quickly, leaving a thin stratum of the solids on the top, which is now covered over with the 3" of earth first removed. The shallow trenches are prepared in succession leaving a space of about 4" between them."

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7. *New varieties of crops*.—Under this head come several crops which have proved themselves of value elsewhere :—

New crops.

Jaunpur Maize.—This variety has done very well at Cawnpur, and is, I believe, superior to that grown in the Cawnpur District generally. It might be grown at the farm in comparison with the variety locally cultivated.

Jaunpur maize.

Bajri.—The Bajri cultivated in many parts of the North-Western Provinces is a much smaller variety of **Pennisetum typhoidium** than that which is common to Gujerat. So far the Gujerat variety has not been grown at Cawnpur, and I cannot express any opinion as to its suitability for the Meerut District. But it has proved itself superior at Poona to the variety which is generally cultivated in that district, and it might be tried at the Meerut Demonstration Farm in comparison with that locally grown.

Bajri.

8. *Methods of Cultivation.*—Under this head there is one innovation which has proved itself at Cawnpur as worth copying and that is the *early* sowing of maize. It has been found at the Cawnpur Farm that if maize be sown in conjunction with irrigation a month before the monsoon begins, *i.e.*, say at the end of May, the outturn is usually very materially increased, the increase being worth far more than the cost of the irrigation. This may possibly be because the plants arrive at such a stage of growth before the monsoon sets in that they are less liable to be damaged by the monsoon storms, than when they are very young. This early cultivation of maize might very well be tried at Meerut, if this practice is not already known in the district.

Maize. Time for sowing.

9. *Implements.*—Under this head, the only implement that I think may properly find a place at this farm is the iron plough. In demonstrating its value to the cultivators, it should be borne in mind that its value is principally that of a *labour-saving machine.* There is no evidence anywhere that any large increase in outturn of crop may be anticipated by its use. But it *has* shown at different places that the tilth required for (say) wheat may be obtained with one-half the number of ploughings which are generally required when the wooden plough is employed. Therefore this fact should be kept prominently in view and the people should (if they will come to see it in use) be shown this difference. I saw two of these ploughs in use at the farm and they were working well and without any difficulty.

Farm implements.

10. *Cattle Breeding.*—I understand from Mr. Wyer that he proposes to keep a stud-bull for the benefit of the cultivators and this I need not say would prove of great value to the cultivators.

Breeding of Cattle.

Fuel and Fodder Reserves.—At a village near Meerut Mr. Wyer has recently planted and sown some trees, the intention being to convert a piece of very poor wasteland into a "Fuel and Fodder" Reserve. It is unnecessary for me to say anything regarding the general utility of providing fuel, and such groves may generally be relied upon to produce more fodder, especially grass, than if lying waste. Of the trees which had been planted, Mangoes and *Jaman* were doing fairly well. But the *Babul* and *Dhak*, which had been grown from seed sown *in situ*, were anything but satisfactory. The soil is not only of poor quality, varying from a light loam to an almost pure sand, but in some parts it also possesses that disagreeable property of forming a hard crust, which, however, is quite superficial. It is only one inch or two in thickness. When sowing the *Dhak* and *Babul*, it appeared to me that the land had not been cultivated sufficiently deep to give the seedlings any chance whatever of developing. In many places the soil had not been stirred 2 inches

Fuel and Fodder.

Fuel and Fodder.

deep. It will be necessary to plough the land considerably deeper than this if success is to be attained. It would doubtless prove advantageous if some night-soil could be put on those portions of the land on which it is desired to grow trees. This would occasion some initial outlay, but on the other hand there would be an earlier return for the capital invested. In connection with this subject the following estimate of cost and outturn of *Babul* firewood which I obtained from Delhi, may be of interest.

Memorandum on Zemindari Kikir Plantation for Fuel.

Zemindari *Kikir* Plantation.

The plantation selected is situated between the second mile of the Agra Canal and the River Jamna, and the area is 250 × 220 = 55,000 square feet, or 1·26 acres. The reason for selecting Zemindari in preference to Government plantations is because a better idea of cost of planting, etc., on waste land can be arrived at, and if a canal plantation is taken the expense would be much higher, for the reason that the *phaora* would be used in place of the plough and the seed would be sown in trenches or ridges, and the lines would have to be made straight, and there would also be jungle clearance, etc , all of which means extra cost and perhaps with no better result than with the seed sown broadcast and ploughed in. The plantation was made in 1887, the land being prepared in the usual manner for wheat growing. The reason why *kikir* has been sown on this land is because it is more profitable than growing crops, principally owing to the damage done to crops by cattle let loose at night to graze on waste land around This plantation land is valued at a yearly rental of four rupees a *paka bigah*, a *bigah* being taken as five-eighths of an acre. The plantation was thinned out when three years old and the owner reckons that the cost for thinning out was about equal to the value of the fuel he received and used for his cooking. The plantation was again thinned out when five years old, and a profit of about twelve rupees made, and will again be thinned out when the trees are about ten years old when a profit of eighty rupees is reckoned on, and the whole plantation cleared when the trees are about fifteen years old. Grazing has been allowed since the second year, but not for goats till the third year. There are now six hundred and eighty trees in the plantation, at the end of fifteen years there will remain about two hundred and forty ; and each tree will weigh from seven to ten maunds, say seven maunds, only then 240 × 7 = 1,680 maunds the owner will have to sell Delhi is the nearest market for the fuel, and that is about 12 miles from the plantation as the carts would have to go; the fuel will be cut for three rupees per hundred maunds and carted for four rupees. In the estimate below of receipts all expenses have been deducted, thus for one hundred maunds of *kikir* he will get at least twenty-seven rupees, for this is a low estimate, and deducting seven rupees the value for one hundred maunds received as profit would be twenty rupees.

Expenditure.

	R	a.	p.
Ploughing and sowing 1·25 acres @ R6 . . .	7	8	0
Rent 16 years @ R 7-14-0 per 1·25 acres, or R4 per *bigah*	126	0	0
Cleaning first year	12	0	0
Total .	145	8	0

Demonstration Farm. (*J. W Leather.*) **IMPROVEMENTS.**

Receipts.

		R	a.	p.
Thinnings	at five years	12	0	0
Ditto	at ten years 400 maunds @ R20 . .	80	0	0
Cutting	at fifteen years 1,680 maunds @ R20 .	336	0	0
Grazing	at twelve years @ R1 each year . . .	12	0	0
	Total .	440	0	0
	Deduct expenditure .	145	8	0
	Profit on 1·25 acres .	294	8	0

Profit on one acre = R 235-9-7.

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G I. C. P. O.—No. 78 R. & A.—21-7-96.—2,100.—E. H.

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THE AGRICULTURAL LEDGER.

1896—No. 19.

SACCHARUM.

(SUGAR-CANE AND RAW SUGAR.)

[*Dictionary of Economic Products, Vol. VI., Pt. II. (Chemistry of Cane and Cane-Sugar)*, S. 61-64.]

CHEMICAL COMPOSITION OF SUGAR-CANE AND RAW SUGARS.

Note by DR. J. W. LEATHER, *Agricultural Chemist to the Government of India, on Results of Experiments at Poona, Cawnpur, Dumraon, and Burdwan.*

COMPOSITION OF SUGAR-CANE AND RAW SUGARS.

Objects of the experiments.

1. The experiments on the growth of Sugar-cane which are being carried out at Poona, Cawnpur, Dumraon, and Burdwan have two principal objects in view. The one is to determine what quantity of manure can be most economically employed and for this purpose different amounts of various manures are applied. The second is the comparative growth of different varieties of cane. The annual results of these experiments are published in the Reports of the several farms named and will not be referred to here.

2. In conjunction with these experiments I have this year, as last year, made a number of analyses and experiments with the object of determining several other points which are of importance. These may be summarised as follows :—

(1) The amounts of Cane-sugar and of Glucose in the juice.
(2) The amounts of Cane-sugar and of Glucose in the raw sugar obtained.
(3) The amount of "Inversion" which occurs during the boiling process.
(4) The quality of the Sugar prepared in the centrifugal machine.
(5) The loss of Sugar which occurs during the boiling process.
(6) The total amount of Sugar in the cane.
(7) The amount of Juice and consequently of Sugar which remains unexpressed from the cane.
(8) The amounts of Nitrogen and of Phosphoric acid in the Sugar-cane crop.

Cane-sugar and Glucose determined.

3. ***The Amounts of Cane-sugar and of Glucose in the Juice.***—The Cane-sugar and Glucose were determined in the juice of six varieties of cane grown at Dumraon, in six varieties at Cawnpur and in three at Poona.

The varieties grown at Dumraon were all manured equally with town sweepings and castor cake.

At Cawnpur five of the varieties were manured with about 1,000 maunds of poudrette, but the sixth ("Matna") was grown on nine plots with different manures, containing very varying amounts of Nitrogen or phosphoric acid, these being, however, so far as the Nitrogen is concerned, very much smaller than in any of the other experiments, and they are in all probability too small to produce a really heavy crop.

At Poona the three varieties were all manured with poudrette containing 500lb of Nitrogen per acre.

It is desirable to consider three points in connection with the results of the analyses of the juice of these varieties:—

(1) The comparative quality of the juice of different varieties grown at the same place.

(2) The comparative quality of the juice of the same variety grown at different places.

(3) The comparative quality of the juice of the same variety grown with very different amounts of manure.

4. ***The Amounts of Cane-sugar and of Glucose in varieties grown at the same place.***—In the two statements Nos. 1 and 2 are set out the percentage amounts of Cane-sugar and of Glucose found in the juice of the varieties of cane grown at Cawnpur and Dumraon.

Cawnpur.

STATEMENT NO. 1.

Six Varieties grown at Cawnpur

	DHAUL.	DIKCHAN.	SAHARAN-PURI.	POONA.	MADRASI.	MATNA.
Manures .	Poudrette 80,000lb.	Poudrette 80,000lb.	Poudrette 80,000lb.	Poudrette 80,000lb.	Poudrette 80,000lb.	*Vide* Statement No. 4.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cane-sugar .	12·74	9·68	15·69	12·48	13·80	16·36
Glucose . .	1·25	1·98	·98	1·77	1·65	·40

Dumraon.

STATEMENT NO. 2.

Six Varieties grown at Dumraon manured with 8,200lb of City Sweepings and 6,560lb Castor cake per acre.

	Mungo.	Khari.	Red Bombay.	Poona.	Samsara.	Bhurli.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cane-sugar .	9·55	11·55	13·70	12·99	13·91	13·01
Glucose . .	1·06	·99	·95	1·16	1·18	·57

NOTE.—Regarding the methods of analysis employed, the cane-sugar was determined in one of Schmidt and Haensch's polariscopes; the glucose was determined by Fehling's volumetric method. Usually two samples of the juice of each plot of cane were analysed and the mean of the two taken.—*J. W. L.*

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These analyses show at a glance how considerable are the variations in the proportion of cane sugar and of glucose in the juice of different varieties of sugar-cane, two of them containing only about 9·5 per cent. of cane-sugar, whilst the Matna (and also the Poona variety as grown at Poona, to which reference will be made below) contains nearly 16·5 per cent. of cane-sugar. The glucose will be referred to more particularly in another part of this note, but it may be here observed that it also varies very greatly indeed—two varieties contain only about ·5 per cent., whilst the juice of another contained nearly 2·0 per cent. **Proportions of cane-sugar and of glucose in different varieties of cane compared.**

Now, bearing in mind that the cost of cultivation, of crushing, and of boiling down the juice of different varieties may be taken as being equal in any particular locality, it will be at once apparent that if the sorts of cane which produce poor juice could be replaced by those producing rich juice, an enormous benefit would be conferred on the cultivator. The juice of the Poona variety is probably not quite so rich as some of the varieties grown in the Mauritius, but it is not much below their best, and it seems not unlikely, that there are in more than one part of India varieties of cane which with a little improvement would become equal to any in the world. Moreover, as will be seen presently (paragraph 5), the evidence which is at hand tends to show that transference of sugar-cane to long distances is accompanied by a lowering of its quality, and it would seem that a search after the best varieties, which are cultivated in a particular province, is perhaps the most important matter to be taken up in order to improve the sugar-producing power of that province.

5. *The Juice of the same Variety grown at different Places.*—The evidence at hand on this head is limited to two cases. The first is that of some cane which was sent from the Mauritius to the Director of Land Records and Agriculture, Bombay, two years ago. Two varieties were sent, one a white and the other a red variety. They were cultivated in 1894-95 and again in 1895-96 at Manjri (Poona) with very liberal amounts of manure. They were said to be varieties which produce juice containing some 18 per cent. of sugar, whilst they grew luxuriantly at Poona, the juice has in neither year contained anything approaching the above Several analyses of the red variety showed only about 10 per cent. of cane-sugar and 2·0 per cent. of glucose, whilst that of the white variety contained about 12 per cent. of cane-sugar and 1·4 of glucose. The second case is that of the variety grown around Poona and which contains about 15 to 17 per cent. of cane-sugar and from 1·0 to 1·5 per cent. glucose. This variety was sent to both Cawnpur and Dumraon last year and, as shown in Statements Nos. 1 and 2, it there contained considerably less, namely, less than 13 per cent. of cane-sugar. The evidence at hand therefore goes to show that sugar-cane may suffer materially in quality by transference to long distances which entails a change of climate. It may be of course that these varieties, after several years of acclimatisation will recover their original qualities, but the process is an expensive one, and if good varieties already exist in a province, it would probably be better to identify these and extend their cultivation than to transfer varieties from long distances. **Poona.**

6. *The Juice of the same Variety grown with different Manures and with different Amounts of Manure.*—At Poona one variety has been grown with a variety of manures. The list includes poudrette, cattle manure, various oilseed cakes, bones, superphosphate and saltpetre. In 1894-95 the amount of Nitrogen applied per acre varied from 200lb to nearly 1,000lb, whilst the phosphoric acid varied from 140 to 2,700lb. In 1895-96 the amount of Nitrogen applied varied from 130lb to 1,000lb, the phosphoric acid from 200lb to 750lb. In neither year was there any

Poona.

relation observable between the quality of the juice and the amounts of manure applied. In 1894-95 the proportion of cane-sugar (*vide* Agricultural Ledger, Medical and Chemical Series, No. 1, page 2), varied, but it is probable that the variation was due to causes, quite apart from the manuring.

The analysis of the juice from these several plots for 1895-96 are set out in Statement No. 3, and it becomes evident that in the case of this series of plots, which received varying amounts of different manures; that the quality of the juice is maintained almost uniformly throughout.

At Cawnpur likewise the series of plots, on which different quantities of manures were applied, lead to a like conclusion. Statement No. 4 exhibits the amounts of manure applied and the quality of the juice obtained and here again the proportions of Cane-sugar and of Glucose remain constant, while the amounts of manure not only varied considerably, but were very much smaller than in the case of the Poona plots.

Poona.

STATEMENT No. 3.

Composition of the Juice from Plots at Poona.

Manures per acre.	Poudrette, N : 1,000lb P_2O_5. 1,500lb.	Poudrette, N : 500lb P_2O_5. 750lb.	Cattle dung, N : 500 : P_2O_5. 200lb.	Farm-yard manure, N: 500: P_2O_5. 530lb.	Safflower cake, N : 500 : P_2O_5. 150lb.	Cotton-seed cake, N : 500 : P_2O_5. 200lb.	Safflower and earthnut cake, N : 500 : P_2O_5. 100lb.	Bassia cake, N : 500 : P_2O_5. 180lb.	Castor cake, N : 500 : P_2O_5. 230lb.	Karanji cake, N : 500 : P_2O_5. 100lb.	Fish manure, N : 500 : P_2O_5. 450lb.	Bone meal, N : 130 P_2O_5. 870lb.	Bone superphosphate, N . 130 : P_2O_5. 870lb.	Bone meal and saltpetre, N : 250 . P_2O_5 870lb.	Bone superphosphate and saltpetre, N : 250 : P_2O_5. 870lb.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cane-sugar	16·46	16·22	16·20	16·36	16·03	15·50	16·61	14·28	15·02	15·03	15·96	16·91	17·30	15·72	16·52
Glucose	1·37	1·47	1·38	1·22	1·55	1·77	1·36	1·87	1·63	1·72	1·52	·95	1·16	1·24	1·31

Cawnpur.

STATEMENT No. 4.

Composition of the Juice of the "Matna" Variety grown on Plots at Cawnpur.

Manures per acre.	No manure.	Cattle dung, 7 tons, N = 94lb.	Cattle dung, 14 tons, N = 188lb.	Bone superphosphate, 5 cwts., N = 17lb.	Saltpetre (crude), 2 cwts., N = 14lb.	Superphosphate, 5 cwts. Saltpetre, 2 cwts., N = 31lb.	Bone meal, 5 cwts, N = 21lb.	Bone meal, 5 cwts Saltpetre, 2 cwts., N = 35lb.	Unmanured.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cane-sugar . .	15·67	16·90	17·04	17·08	16·74	15·14	15·03	16·58	16·03
Glucose . .	·57	·50	·37	·31	·31	·51	·44	·29	·32

Thus it appears evident that the quality of the juice of any particular variety is not *materially* affected by the amount or description of manure applied. I say *materially*, because I should not wish to imply that manuring can have *no* influence. On the contrary, and quite apart from the question of the amount of cane grown per acre or of other properties of sugar-cane to be discussed later, which is altogether distinct from the point under discussion, I believe that the quality of the juice of sugar-cane may be improved by good cultivation and liberal manuring. I have seen cane in Behar which had lost all the usual appearance of the crop and which I thought was reeds; a condition brought about, I do not doubt, by the scanty manuring applied. But I think the evidence above set out goes to show that the improvement in the quality of the juice of a cane will at the best be a slow process. It also seems evident that we may place fair reliance on the information conveyed in Statements Nos. 1 and 2 in which the quality of the juice of different varieties was exhibited. It can hardly be suggested, for instance, that they are accidental in any way; it must rather be assumed that the composition of their juices as there stated is really what it is in ordinary practice. With the exception of the "Poona" variety, they were not brought from long distances to the farms in question, but belonged to the respective provinces, and we may, I think, safely conclude that, for example, the varieties Dhaul and Dikchan of the North-West Provinces and the Mungo and Khari varieties of Bengal are poor and may easily be replaced by better ones already at hand.

How the quality of the juice may be improved.

7. ***The Composition of the Raw Sugar ("Gur") or "Gul" obtained.***—Before discussing the analyses of the raw sugars, it will be well to

first set out the objects which were kept in view. So far as the cultivator's palate is concerned, it matters probably little whether his "*gur*" contains much or little molasses. Glucose is to him much of the same value as cane sugar. In the bazar, however, buyers make a difference between "*gur*" which is nice and firm and showing a good colour and crystal, and *gur* of bad colour and softness. The *banya* who buys for either refining or sweetmeat making or for the simple retail of *gur*, has to warehouse large quantities, and during the rains the mass is very apt to absorb moisture and run. The higher the proportion of glucose, the greater will be the loss, and thus, quite apart from the comparative value of raw sugars to the large refiner, the matter is of considerable moment to the cultivator in all large sugar-producing districts. To the refiner the matter is of still greater moment. Each part of glucose will prevent an equal weight of cane-sugar from crystallising.

Gur for the market should be firm and of good colour.

Now the proportion of glucose in the raw sugar depends not only on the amount present in the juice, but also on the amount which is formed during the boiling down process. As in the case of plant juices generally, that of the sugar-cane is slightly acid. When a solution of cane sugar is boiled with a dilute acid, it becomes "Inverted," *i.e.*, converted into glucose. The amount or extent of this inverting process depends on the nature of the acid, its strength and on the length of time the solution is kept boiling. The amount of acidity* in those cane juices which were examined, varied somewhat as will be seen from the accompanying statements though it is in all cases very small. It is due to the presence of several different organic acids, and while the juice is being boiled down, this acidity causes the inversion of a certain quantity of cane sugar. This inversion may, at least in part, be prevented. I mentioned in my note on this subject last year that a little alkali (potash) was added to the juice at Cawnpur before boiling down. This year I carried out several experiments with lime, instead of potash. The latter has the disadvantage that it is itself a means of preventing cane-sugar from crystallising, whilst lime, in the small quantity used, does no harm. The extent to which it prevented "inversion" will be seen presently. In order to determine the extent of inversion, it is necessary to compare the relative quantities of glucose in the juice and in the "*gur*" obtained, and the following Statements, Nos. 5, 6, 7, 8, are drawn up with this object. In each is set out first the percentage composition of the juice and of the *gur* respectively, and then, in order to show at a glance the relative amount of the glucose in the juice and in the *gur*, its proportion per 100 parts of total sugar is printed in thick type.

Acidity.

"Inversion" may be prevented

It will be seen that the proportion of glucose in the juice varies very greatly from about 2 parts per 100 of total sugar in the Matna variety to no less than 17 in the Dikchan variety (Statements Nos. 6 and 7). In the *gurs*, there is on the whole much more uniformity, it is in the majority of cases about 10 to 14 parts per 100 of total sugar, though exceptions occur such as the Dikchan *gur* which contained 22 of glucose per 100 of total sugar.

* The acidity was determined by neutralising the juice with standard alkali, litmus paper being used as the indicator. The juice is too strongly coloured to allow of any indicator being used in the liquid and clearing agents are inadmissible. Cochineal gave too high results and phenolphthalein is inadmissible since the juice contains carbonic acid. The figures represent parts of K_2O required to neutralise the acidity of 100 parts of juice. Since the acidity is due to a variety of acids, this mode of expressing the result is preferable.

SACCHARUM. **Chemical Composition of**

Dumraon.

STATEMENT No. 5.

Composition of Juice and "Gur" from six Varieties grown at Dumraon 1895-96.

	Mungo.	Khari.	Red Bombay.	Poona.	Sam-sara.	Bhurli.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Juice—						
Cane-sugar . . .	9·55	11·55	13·70	12 99	13·91	13·01
Glucose	1·06	99	·95	1·16	1·18	·57
TOTAL SUGAR .	10·61	12 54	14·65	14·15	15·09	13·58
Ratio: 100 parts of Total Sugar contain of Glucose.	10·0	7·9	6·5	8 2	7·8	4·2
Gur—						
Cane-sugar . . .	71·85	68·07	73·99	69·20	70·60	77·46
Glucose	11·37	9·39	9·81	10·31	10·79	5·27
TOTAL SUGAR .	83·22	77·46	83·80	79·51	81·39	82·73
Ratio: 100 parts of Total Sugar contain of Glucose .	13·7	12·1	11·8	12·9	11·9	6·3

Cawnpur.

STATEMENT No. 6.

Composition of Juice and "Gur" from six Varieties grown at Cawnpur, 1895-96.

	Dhaul.	Dik-chan.	Saharan-puri.	Poona.	Mad-rasi.	Matna.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Juice acidity . . .	·055	·049	·006	·018	·049	·074
Cane-sugar	12·74	9·68	15·69	12·48	13·80	16·36
Glucose	1·25	1·98	·98	1·77	1·65	·40
TOTAL SUGAR .	13·99	11·66	16·67	14·25	15·45	16·76
Ratio: 100 parts of Total Sugar contain of Glucose .	8·9	16·98	5·8	12·4	10·6	2·3
Gur—						
Cane-sugar . . .	68·67	62·99	70·92	69·72	69·06	71·71
Glucose	11·40	17·99	9·94	13·90	12·82	10·35
TOTAL SUGAR .	80·07	80·98	80·86	83·62	81·88	82·06
Ratio: 10 parts of Total Sugar contain of Glucose . .	14·2	22·2	12·3	16·6	15·6	12·6

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Cawnpur.

Statement No. 7.

Composition of Juice and "Gur" of the "Matna" Variety grown at Cawnpur with different manures, 1895-96.

Manures per acre.	No manure.	Cattle dung, 7 tons per acre.	Cattle dung, 14 tons per acre.	Bone superphosphate, 5 cwts.	Saltpetre, 2 cwts.	Superphosphate, 5 cwts. Saltpetre, 2 cwts.	Bone meal, 5 cwts.	Bone meal, 5 cwts. Saltpetre, [illegible] cwts.	No manure.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Juice—									
Cane-sugar . .	15·67	16·90	17·04	17·08	16·74	15·14	15·03	16·58	16·03
Glucose . .	·57	·50	·37	·31	·31	·51	·44	·29	·32
Total Sugar .	16·24	17·40	17·41	17·39	17·05	15·65	15·47	16·87	16·35
Ratio: 100 parts of Total Sugar contain of Glucose .	3·5	2·8	2·1	1·79	1·8	3·2	2·8	1·7	1·9
Gur—									
Cane-sugar . .	72·51	71·28	72·73	68·76	72·04	69·70	72·74	71·85	73·80
Glucose . .	8·54	10·39	9·46	12·88	10·57	13·96	10·15	9·91	7·33
Total Sugar .	81·05	81·67	82·19	81·64	82·61	83·66	82·89	81·76	81·13
Ratio: 100 parts of Total Sugar contain of Glucose .	10·5	12·6	11·5	15·7	12·8	16·7	12·2	12·1	9·0

SACCHARUM. **Chemical Composition of**

Poona.

STATEMENT No. 8.

Composition of Juice and "Gur" from the Poona Sugar-cane grown at Poona with different manures.

Manures per acre.	Poudrette, N: 1,000lb P$_2$O$_5$. 1,500lb.	Poudrette, N: 500lb P$_2$O$_5$. 750lb.	Cattle dung, N: 50:lb P$_2$O$_5$. 200lb.	Farm-yard manure, N 500lb P$_2$ O$_5$. 530lb.	Safflower cake, N · 500, P$_2$O$_5$. 150lb.	Cotton seed cake, N: 500 P$_2$O$_5$. 200lb	Safflower and Earthnut cake, N: 500 P$_2$O$_5$. 100lb	Bassia cake, N: 500 P$_2$O$_5$. 180lb.	Castor cake, N: 500 P$_2$O$_5$. 230lb.	Karanji cake, N: 500 P$_2$O$_5$. 100lb	Fish Manure, N 500 P$_2$O$_5$. 450lb	Bone meal, N · 130 P$_2$O$_5$. 870lb.	Bone superphosphate, N 130 P$_2$O$_5$. 870lb.	Bone superphosphate, and Saltpetre, N 500 P$_2$O$_5$. 870lb.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Juice—														
Acidity	·061	·049	·061	·	...	·074	...		·049	·061	·049	..	·049	·061
Cane-sugar	16·46	16·22	16·20	16·36	16·03	15·50	16·61	14·28	15·02	15·03	15·96	16·91	17·30	16·52
Glucose	1·37	1·47	1·38	1·22	1·55	1·77	1·36	1·87	1·63	1·72	1·52	·95	1·16	1·31
TOTAL SUGAR .	17·83	17·69	17·58	17·58	17·58	17·27	17·97	16·15	16·65	16·75	17·48	17·86	18·46	17·83
Ratio · 100 parts of Total Sugar contain of Glucose	7·68	8·3	7·8	6·9	8·8	10·2	7·5	11·6	9·78	10·2	8·69	4·97	6·2	7·3
Gur—														
Cane-sugar	77·96	74·93	76·55	75·19	75·35	75·99	76·61	73·16	76·48	7[illegible]·67	75·95	73·17	69·71	72·85
Glucose	9·88	11·20	10·80	11·75	11·44	10·61	9·86	12·50	10·46	12·47	11·90	12·18	16·23	15·05
TOTAL SUGAR .	87·84	86·13	87·35	86·94	86·79	86·60	86·47	85·66	86·94	86·14	87·85	85·35	85·54	87·90
Ratio: 100 parts of Total Sugar contain of Glucose	11·2	13·1	12·8	13·5	13·1	12·2	11·4	14·59	12·0	14·4	13·5	14·27	18·8	17·2

S. 61-64.

Cawnpur.

There is, however, considerable variation in the amount of glucose formed during boiling down. The juice of the Matna variety at Cawnpur contained only about 2 parts of glucose per 100 of sugar, whereas its *gur* contained more than 12 on an average of nine samples (Statement 7), 10 parts being thus formed during the boiling process. On the other hand, the Bhurli variety at Dumraon had 4 parts in the juice and only 6 in the *gur*, showing a very slight amount of inversion. There seems to be no clear relation between the amount of acidity and the amount of inversion.

Dumraon.

How to prevent glucose formation.

8. It is possible (and perhaps practicable), however, to prevent in a great measure this glucose formation. As already indicated, experiments with quicklime were made at Cawnpur and Poona to test how far success might be attained in this manner, and I must here thank Mr. McGlashan, F.C.S., of the Cawnpur Sugar Works, Limited, for the interest he took in the matter. In order to obtain the best results it was desirable to add as much lime to the juice before boiling as would *nearly but not quite* neutralise all the acidity. If an excess of lime be employed, the resulting *gur* is black and would command no price in the bazars, although, as will be seen below, its quality is really not lower than that of ordinary *gur*. To do this, the lime was added in the form of "milk of lime," (*i.e.*, quicklime and water made into a thin cream and separated from all lumps, stones, etc.) to a definite proportion of the juice for each pan operated upon until that portion was quite neutral or very slightly alkaline. The remaining portion of juice was then mixed with the neutral portion and the whole thus became slightly acid. Thus, for example, if it was desired to neutralise $\frac{3}{4}$ of the acidity, $\frac{3}{4}$ of the juice which was intended for one pan was separately neutralised with the milk of lime and then the remaining $\frac{1}{4}$ was added, by which means a juice was prepared containing only $\frac{1}{4}$ of the original amount of free acid. Or, again, if it was desired to neutralise $\frac{9}{10}$ of the acidity $\frac{9}{10}$ of the juice intended for the one boiling was neutralised and then the remaining $\frac{1}{10}$ of the juice was mixed with the neutral portion and a juice was obtained containing approximately only $\frac{1}{10}$ of the original acidity. The process is extremely simple, and although litmus paper must be employed to determine when sufficient lime has been added (it is added by the spoonful), I believe that cultivators might be able after a very little practice to perform the operation perfectly well, assuming, of course, that it should be worth their while to go to the trouble to do so. They all know how many "*ghurras*" of juice go to a panful, and hence there is no difficulty in their measuring off the right amount for neutralising. The results of the experiments are set out in Statement No. 9.

Use of lime.

Effect of neutralising Juice with lime before boiling.

STATEMENT No. 9.

Showing the effect of neutralising Juice with Lime before boiling.

	Cawnpur Experiments.					Poona Experiments.	
	Matna variety.			Saharanpuri variety.	Madrasi variety.	Plot 7.	Plot 9.
Juice—							
Cane-sugar	16·74	16·58	16·03	15·69	14·10	15·96	15·03
Glucose	·31	·29	·32	·98	1·35	1·52	1·72
Total Sugar .	17·05	16·87	16·35	16·67	15·45	17·48	16·75
Ratio: 100 parts of Total Sugar contain of Glucose.	1·8	1·7	1·9	5·8	8·7	8·69	10·2

Amount of acidity neutralised.	No lime.	Indefinite.	No lime.	Alkaline.	No lime.	3/4	No lime.	6/7	1/4	No lime.	11/17	No lime.	1	No lime.	9/16
Gur—															
Cane-sugar . . .	72·04	74·96	71·85	75·76	73·80	73·94	70·92	78·80	78·43	69·06	77·41	75·95	79·88	73·67	78·00
Glucose	10·57	6·66	9·91	1·62	7·33	5·31	9·94	5·35	5·08	12·82	7·57	11·90	9·00	12·47	9·60
Total Sugar .	82·61	81·62	81·76	77·38	81·13	79·25	80·86	84·15	83·51	81·88	84·98	87·85	88·88	86·14	87·60
Ratio: 100 parts of Total Sugar contain of Glucose.	12·8	8·16	12·1	2·09	9·0	6·70	12·3	6·36	6·08	15·6	8·9	13·5	10·1	14·4	10·9

S. 61-64.

Cawnpur.

It will be seen that in all cases the proportion of glucose formed during the boiling process was very much less after the addition of lime. In two cases, where only $\frac{1}{10}$ and $\frac{1}{17}$, respectively, of the acidity was left unneutralised, there was practically no inversion. Also when a slight excess of lime was employed and all the acid neutralised, there was no increase in the amount of glucose. In the majority of cases there was some inversion, but much less than when no lime was added. In the case of the juice of the Matna variety at Cawnpore, the juice was all used up before I knew how much lime might safely be added. When $\frac{3}{4}$ of the acidity was neutralised the inversion was still considerable, but it may fairly be assumed that if about $\frac{9}{10}$ of the acidity had been neutralised, there would have been very little inversion. Thus generally it may be said that, if lime can be employed, a juice containing a low percentage of glucose may be valued much higher than one containing a high percentage, although without the addition of lime or some other neutralising agent, this advantage is not necessarily maintained. The Matna variety contained a very low proportion of glucose in the juice but this was (excepting after addition of lime) of no value, for the *gur* obtained from this cane contained a fairly high proportion (about 12 per cent. *vide* Statement No. 7) under ordinary circumstances.

Mr. McGlashan informs me that the sample of *gur* which was $\frac{3}{4}$ limed (*vide* statement) was better than average "*putri*" or strained *râb* costing about R5-5-0 per maund.

9. ***The Refining of Jaggery by the Hand Centrifugal Machine.***—Quite apart from any market which may exist for raw sugar required by large refineries, there appears to be a considerable demand for semi-refined sugar by small refiners.

Demand for semi-refined sugar.

To the poorer class of cultivator molasses or a *gur* containing a high proportion of glucose, is just as good a food as ordinary *gur*. The feeding value of the two may be said to be identical. On the other hand the refiner wants as little molasses (glucose) as possible. The less its amount, the less trouble will he have in his manufacture. It follows, therefore, that if, instead of *gur* being sent to refiners, semi-refined sugar be sent and the molasses retained by the grower, a distinct economy will be effected.

Hand centrifugal machine.

This is precisely the state of things which I found around Behea. The juice, instead of being boiled down hard to the form of *gur*, is largely converted into a semi-liquid jaggery from which, by the aid of Messrs Thomson and Mylne's hand centrifugal, most of the molasses is separated from the sugar crystal and retained for local consumption, whilst the semi-refined sugar is sold. I have to thank Mr. Mylne for showing me some of these machines at work and for some valuable information on the subject. Doubtless the proportion of sugar crystal obtained will vary and depend on the sort of juice and on the method of boiling employed. But from what I could learn the semi-pure sugar obtained amounts to about one half of the jaggery* operated upon, the other half consisting of a liquid molasses which, on boiling down, forms a *gur* which is perfectly good for human consumption. The market value of the different materials were as follows at the time of my visit:—Ordinary *gur* 12 seers the rupee; semi-refined sugar 6 seers; *gur* made from the molasses 14 seers. Thus a maund of ordinary *gur* would have sold for R3-5-0, whilst if the same quantity of juice had been converted into jaggery and refined in the centrifugal, there would be obtained

* I apply the term jaggery to the semi-solid mass which is prepared by staying the boiling process at an earlier stage than is the case when *gur* is prepared.

Analysis of semi-refined sugar.

20 seers of sugar worth R3-5-0 and 20 seers of second quality *gur* of value R1-8-0. The profit would not be quite so large as these figures indicate, because of the cost of boiling the molasses down again, but the above example will show that it may readily pay a cultivator to convert a part of his juice into jaggery and prepare semi-refined sugar from it, instead of selling it all as *gur*.

The following analyses of samples of semi-refined sugar will illustrate their composition. There is in addition one analysis of a sample of the *gur* made from the molasses :—

STATEMENT No. 10.

	Sugar obtained by the Centrifugal.	*Gur* from the molasses of the same.	Sugar obtained by the Centrifugal.	Sugar purified by wet weed.
Cane-sugar	89·48	65·71	92·20	96·67
Glucose	3·34	13·81	1·95	·89
	92·82	79·52	94·15	97·56
Ratio: 100 parts of Total Sugar contain of Glucose .	3·6	17·3	2·0	·91

It will be seen that the *gur* which was prepared from the molasses was of not at all very poor quality, indeed it was nearly as good as some of the *gurs* which were prepared from juice direct at the farms.

10. *The Loss of Sugar which occurs during the boiling down Process.*— The loss of cane-sugar caused by inversion has already been dealt with. There is, however, another source of loss during the boiling process which I have attempted to estimate. Assuming that we have determined by analysis the percentage amount of sugar in any particular quantity of juice and that we know the weight of the juice; and secondly, if we similarly determine the percentage amount of sugar in the *gur* obtained and that we likewise know its weight, the weight of sugar in the juice employed and in the *gur* obtained may be readily calculated. If no loss (excepting inversion which is not a loss in the sense in which the word is applied in this paragraph, for if cane-sugar becomes "inverted" it forms glucose) occurred, the total amount of sugar found in the *gur* should be equal to the total sugar in the juice.

Source of loss of cane-sugar other than that caused by "inversion."

In making such a calculation, however, it becomes necessary to bear in mind what the "errors of experiment" may be. In the analysis of the juice the error may amount to ± ·1 per cent. of total sugar; in the analysis of the *gur* it may amount to ± ·2 per cent. of total sugar. Both these possible errors are insignificant to the question at issue. A greater source of error may occur in taking the samples of juice and *gur*. For the former a sample was taken either from the tin cans at each mill which was done at Cawnpur, each sample bottle of juice thus containing juice from eight different mills all crushing one sort of cane, or the bottle was filled (as at Poona) from the large cisterns, two of which are filled as a measure of the juice for one boiling; in the latter case each sample represented about 900lb of juice. Even with these precautions varia-

Errors in calculation to be guarded against.

tions were frequently found between the composition of the juice of the same plot of cane; this variation sometimes amounted to 0·8 or 0·9 per cent. of total sugar, though in the majority of cases it fell to less than 0·4 per cent. Assuming a juice to contain 17 per cent. of total sugar, a difference of ·8 per cent. between two samples would be equivalent to 4·7 per cent. of the total sugar; we may, however, fairly assume that the mean of the two analyses would really represent the average composition of the juice of a plot of cane, or that at the most the error would not be greater than 2·3 per cent. of the total sugar. In the majority of cases, however, the difference between the composition of two samples of juice from the same plot of cane fell below this figure.

Mode of taking sample of *gur*

In the case of the *gur*, the sample could be very perfectly obtained. A long iron instrument of semi-circular form, like the one employed for sampling cheese, though much longer, was driven into the blocks of *gur* and on withdrawing it, a circular slice of *gur* the whole length of the cut adhered to the instrument. A portion from the centre of this slice was taken from each block (or from one half of the blocks if the number be large) and these portions on being mixed together give a very perfect average sample of the *gur* of the whole plot. It may be mentioned here that although *gur* is quite solid in the ordinary sense, still the molasses *do* pass gradually downwards and a piece chipped from the top of a block might contain less glucose than a piece taken from the bottom. The advantage of obtaining the sample from the very centre will thus be apparent. Only one sample of *gur* was analysed from any one plot, but the error of sampling when done in the manner above described cannot be supposed to be anything appreciable. In the accompanying Statement No. 11 the weight of juice, the percentage of total sugar and the calculated weight of total sugar in the juice is placed in the upper portion; in the middle portion is stated the weight of *gur* obtained, the percentage of total sugar in the *gur* and the calculated weight of total sugar in it. Finally, we have the difference between the weight of sugar in the juice and in the *gur* respectively and the percentage of loss.

STATEMENT NO. 11.

Showing Loss which occurs when boiling down Juice.

	CAWNPUR EXPERIMENTS.				POONA EXPERIMENTS.			
	Matna variety.	Poona variety.	Madras variety	Saharanpuri variety.	Plot 18.	Plot 19.	Plot 20	Plot 21 (1 boiling).
Juice . . lb	1,807	2,492	2,833	1,920	11,420	13,284	12,833	900
Total Sugar per cent.	16·24	14·25	15·45	16·67	17·2	16·75	17·17	16·14
Do. . . lb	293	498	437	320	1,968	2,224	2,203	145·3
Gur . . lb	316	534	460	352	1,922	2,238	2,210	151
Total Sugar per cent.	81·06	83·62	81·88	80·86	88·1	89·69	87·92	87·26
Do. . . lb	256	446	376	284	1,693	2,008	1,943	131·7
Loss . . lb	37	52	61	36	275	216	260	13·6
Do. per cent.	12·6	10·4	13·9	11·2	13·95	9·76	11·80	9·3

This has been calculated for four plots at Cawnpur and for three plots at Poona; in addition to which there is the result of a careful experiment on one pan of juice made at Poona.

Loss which occurs when boiling down juice explained.

It will be seen that usually the loss amounts to more than 10 per cent of the sugar; the figures obtained from the Cawnpur experiments agreeing closely with those at Poona. There are two reasons for this loss, the one being due to juice which is unavoidably carried off with the scum, whilst the second one is due to sugar which adheres to the cloth lining of the mould into which the *gur*, whilst still warm and soft, is put. The experiment on one pan of juice at Poona was made to determine how much sugar is carried off by the scum. In this case the total loss amounted to 9·3 per cent. It was intended to collect all the scum, weigh it and analyse it. But it is difficult to do this. As the "drainer" with which the scum is separated, is passed from the pan to the vessel in which the scum is put, some drips on the ground; and again the sugar boiler has to give the drainer each time a violent shake to detach some of the scum, and it thus happens that all the scum was not actually collected. In the experiment under notice the scum weighed 24lb. It contained 27·45 per cent. of sugar and this amounts to 6·6lb of sugar. Of the 9·3 per cent. of loss, 4·5 per cent. was thus accounted for. But since some part of the scum was lost the amount of sugar in the scum may be safely assumed to be greater than this; probably 6 per cent. of the loss would more accurately represent it. The remainder must be assumed to be attached to the cloth. Now, although it is thus seen that a loss of more than 10 per cent. of the sugar in the juice is sustained, it happens that that portion which goes with the scum is usefully employed. At Cawnpur the scum was fed to cattle. At Poona an arrangement exists with the man who supplies all the ropes, that he shall have the scum as payment. He takes it and prepares *gur* from it, and considering that it contains such a high percentage of sugar, it will be evident that, although the preparation of sugar from it will entail some little trouble, still it can be profitably done. It is a matter of satisfaction to find that this sugar is not wasted and affords another example of how economical the cultivator is, when by means of patience he can be so.

II. *The Total Amount of Sugar in the Cane.*—As is well known, the amount of sugar which actually exists in the cane is far greater than that which is expressed by any mill. It appeared nevertheless, of interest to make some determinations of the total sugar in different sorts of cane, partly because such determinations have not been previously made (so far as the writer is aware) for Indian canes, but more particularly because from different sorts of cane very different amounts of juice are expressed, and this independently of the exact description of mill employed. Last year an attempt was made to determine the total sugar in the cane, and also (since we can calculate the amount of sugar in the juice expressed) the sugar in the refuse cane; the sum of the two latter would form a check on the correctness of the former. It has been found impossible, for several reasons, to determine the sugar in the crushed cane directly with any degree of exactness, and reliance must be placed on the determinations of the total sugar in the cane and in the juice. As will be seen, however, these are probably very near the truth and some interesting results are obtained.

It will be well in the first place to explain the process employed for the purpose. A succulent plant stem may be said to consist of two principal parts, the one is juice and the other is "crude fibre," which consists principally of cellulose and other insoluble carbo-hydrates. The former, the juice, is a watery liquid, whilst the crude fibre is practically insoluble in cold water. If, therefore, the stem (after being suitably cut up so as to admit water to pass among the fibres) be treated with water, the latter will wash away the juice entirely, leaving the "crude

Total amount of sugar in the cane.

fibre" behind and the latter may be dried and weighed. In the analysis of cattle fodders chemists have usually found it more exact to employ hot water in washing the juice or soluble portion from the crude fibre. In the case of sugar-cane, I have employed (for the purpose under discussion, namely, the estimation of the juice and sugar) only cold water, for our object is to separate only those matters from the crude fibre which are dissolved in the juice, *i.e.*, in a cold watery fluid. If, then, we thus separate the crude fibre and weigh it, the other portion is considered to be juice. Having determined the proportion of juice we can, from its analysis, calculate the amount of sugar, or any other of its constituents which are present, from the percentage of juice found in any cane. Thus, if we found 10 per cent. of crude fibre in a cane the difference, or 90 per cent., would be juice; and if that juice contained 15 per cent. of sugar, the proportion of sugar in the cane would be (90 × 15 ÷ 100) 13·5 per cent. As a check on this method we have other evidence. A succulent stem, if dried at a temperature not exceeding the boiling point of water, will lose its water entirely, and we have remaining what is commonly termed by chemists the "dry matter." Now it will be evident that this dry matter contains the "crude fibre" and the sugar and other solid substances which exist in the juice. If, therefore, to the crude fibre we add the amount of sugar, mineral matter and albuminoids found in the juice, the sum should equal approximately the amount of "dry matter." In the case of sugar-cane juice the greater part of the solid matters dissolved in it consist of sugar; the amount of mineral matters and albuminoids are very small as will be seen when examining the statements. In the example above quoted, the dry matter should be a little more than the crude fibre + the sugar or rather more than 23·5 per cent. Thus a check is placed on the determination of the total sugar in the cane, which would show what errors might exist in the process of analysis. The weak point in the method lies in the fact that only small quantities of cane (about 2 to 3 ozs. cut from 3 or 4 canes) could be operated upon, and although average sized canes were chosen for the purpose, still the sample thus obtained is much more open to doubt than the samples of juice. The method is not supposed to be quite accurate, but the results obtained are sufficient for the purpose.

12. The accompanying Statement No. 12 will now be readily understood. All the figures represent parts per 100 parts of fresh sugar-cane.

STATEMENT NO. 12.

The Composition of Sugar-cane.

	POONA CANE.		CAWNPUR EXPERIMENTS.				
	Plot 2.	Plot 11.	Dhaul.	Dikchan	Matna.	Saharanpuri.	Madrasi.
Dry matter	24·90	23·69	24·35	23·26	29·51	25·94	24·58
Water	75·10	76·31	75·65	76·74	70·49	74·06	75·42
Crude fibre	8·33	8·52	12·72	11·00	14·81	10·34	10·00
Juice	91·67	91·48	87·28	89·00	85·19	89·66	90·00
Crude fibre	8·33	8·52	12·72	11·00	14·81	10·34	10·00
Total Sugar	16·11	16·31	12·21	10·38	14·27	14·95	13·90
Albuminoids in juice	·09	·09	·10	·12	·16	·33	·14
Mineral matter in juice	·25	·34	·49	·40	·40	·29	·42
	24·78	25·26	25·52	21·90	29·64	25·91	24·46

Composition of sugar-cane from Poona and Cawnpur considered

In the first two columns of the statement are the results obtained by the analysis of samples of cane from two plots at Poona, both of which are of the same variety, and the result will indicate that the method employed may be relied upon. In the other five columns are the results of the analysis of five varieties of cane grown at Cawnpur. In the upper part of the statement is exhibited the proportion of water and of dry matter in each sort of cane. The second section of the statement shows the proportion of crude fibre and of juice. In the third section are found the proportions of crude fibre, and of sugar, ash and albuminoids which existed in the juice, and the sum of these may be compared with the dry matter. In two cases the total of the determined constituents is somewhat too high and in a third it is a little low, in the other four cases the results coincide approximately with the dry matter. It will be seen that the proportion of crude fibre varies very considerably, some varieties containing nearly twice as much as others. The percentage of juice, on the other hand, varies from 85 per cent. to about 92 per cent.

The percentage of total sugar varies from 10 per cent. to more than 16 per cent. It may be mentioned here that the best cane produced abroad does not contain more than 18 per cent. of sugar, and consequently it may be asserted that we have in the variety grown at Poona a cane which is nearly equal to any in the world. It contains, moreover, a low proportion of crude fibre, a quality which, as will appear from the considerations discussed in the next paragraph, is of some moment. Of the varieties grown in the North-West Provinces, the "Saharanpuri" contains about 15 per cent. sugar, which is high, but the proportion of crude fibre is higher than in the Poona cane. The variety "Matna" contains a fairly high proportion of sugar but it also contains a *very* high proportion of *crude fibre*. The varieties Dikchan and Dhaul rank far below, for they contain low proportions of sugar and high proportions of crude fibre.

13. ***The Amount of Juice and, consequently, of Sugar which remains unexpressed from the Cane.***—Having determined the amount of juice and from this the amount of sugar which different canes contained, we may now compare this information with the amount of juice and sugar expressed. In the Statement No. 13 is set out, for the same seven samples of cane as were referred to in the foregoing paragraph, the total juice in the cane, the proportion expressed by the mills, and the difference or that remaining in the refuse cane; then similarly the total sugar in the cane, the amount expressed in the juice and that part remaining in the crushed cane; finally in the third section of the statement the relative proportions of crude fibre and juice in 100 parts of *crushed* cane. A glance at the figures in the first section of the statement shows that, whilst there is no very great difference in the proportion of juice which the varieties contain, the amounts expressed vary enormously; from the cane at Poona more than 70 out of 91 per cent. of juice was obtained, whilst from the Matna variety at Cawnpur only about 45 out of 85 per cent. was realised. The other varieties occupy an intermediate position. At first sight it would be suspected that the mills were at fault and that the high proportion of juice expressed at Poona indicated that the mills employed there were better than those employed at Cawnpur. So far as this point is concerned, I believe that the mills employed at Cawnpur were in several cases (8 mills were used) bad ones and possibly better mills would have expressed rather more. But this will not in any case account for the great differences which were found. From the Poona variety (grown at Cawnpur) 65 per cent. was expressed which is distinctly less than what was obtained from this variety at Poona. But a comparison of the results of

crushing the several varieties at Cawnpur show that, whilst 64 out of 90 per cent. of juice was obtained from the Madrasi variety, only 45 out of 85 per cent. was got from the Matna, and this under perfectly similar conditions as regards mills.

Amount of juice and of sugar that remains in the cane.

STATEMENT NO. 13.

Amount of Juice and Sugar remaining in the Crushed Cane.

	POONA CANE.		CAWNPUR EXPERIMENTS.				
	Plot 2.	Plot 11	Dhaul	Dikchan	Matna.	Saharanpuri.	Madrasi.
Juice in Cane	91·6	91·5	87·3	89·0	85·2	89·6	90·0
Do. expressed	71·6	72·2	51·2	56·0	45·4	57·4	64·1
Do. in refuse Cane	20·0	19·3	36·1	33·0	39·8	32·2	25·9
Total Sugar in Cane	16·11	16·31	12·21	10·38	14·27	14·95	13·90
Do in Juice expressed	12·59	12·87	7·15	6·53	7·60	9·56	9·90
Do. In refuse Cane	3·52	3·44	5·06	3·85	6·67	5·39	4·00
Composition of the refuse Cane							
Crude fibre	29·4	30·7	26·1	25·0	27·1	24·3	27·8
Juice	70·6	69·3	73·9	75·0	72·9	75·7	72·2
	100·0	100·0	100·0	100·0	100·0	100·0	100·0

If, however, instead of making comparisons of the amounts of juice the crude fibre and the part it plays be considered, an explanation offers itself.

As soon as the cane is broken and whilst still in the mill, the crude fibre may be likened simply to a sponge. The cells which enclosed the juice in the original cane are broken and there is nothing to prevent the juice from leaving the cane excepting the physical property of adhesion. Thus, then, such being the case, the amount of juice which will remain with any refuse cane as it leaves the mill, will depend principally on the amount of spongy material; in other words, on the *crude fibre* present. The lower portion of the statement exhibits this very clearly, for the refuse cane of all the five varieties at Cawnpur consisted of 25 to 27 per cent. of crude fibre and 73 to 75 per cent. of juice, showing that the mills had worked very uniformly indeed in each case.

At Poona the cane must have been unquestionably better crushed, for the refuse cane consisted of 30 per cent. of crude fibre and 70 per cent. of juice. It thus becomes apparent that the proportion of crude fibre in any cane is a very important factor, for it may be stated as approximately correct that *the amount of juice remaining in the crushed cane varies directly with the proportion of crude fibre in the cane.* The Matna variety contains about 15 per cent. of crude fibre and held 40 per cent. of juice within its substance when crushed; the Poona variety (crushed with an entirely different mill at Poona) contained 8 per cent. of crude fibre and retained 20 per cent. of juice—proportions which are nearly identical. It will thus become apparent why it is that, although the Matna variety contained 85 per cent. of a juice containing nearly 17 per cent. of sugar, it is but a very poor cane for crushing purposes. Of the 14 per cent. of sugar in the cane only a little more than half was expressed, whereas in the case of the Saharanpuri and Madrasi varieties $\frac{2}{3}$

Nitrogen and Phosphoric Acid in the crop.

of the sugar they contained was expressed, and from the Poona variety (grown at Poona) the proportion rises to $\frac{1}{4}$. It may be said, therefore, that it is little good growing a cane with very rich juice if the proportion of crude fibre is likewise high; a low proportion of crude fibre is indeed of greater importance than the possession of a good mill.

14. ***The Amount of Nitrogen and Phosphoric Acid in the Sugar-cane Crop.***—Last year an approximate estimate of the amount of Nitrogen and of Phosphoric acid in the sugar-cane crop was made, but it appeared to be worth while to make accurate determinations of these two constituents, for this crop is generally considered to be a very exhausting one. Samples were, therefore, taken of the sugar-cane, of the green leaves and tops of the cane which are not passed through the mill, and of the dry leaves which are stripped off the cane when it is harvested. The weights of these were also recorded and from this and the percentage found by chemical analysis, the weight of Nitrogen and Phosphoric acid may be readily calculated. The accompanying Statement No. 14 exhibits the results for two varieties grown at Dumraon and two at Cawnpur. The largest amount of Nitrogen was taken up by the "Madrasi" crop at Cawnpur and the largest amount of Phosphoric acid by the "Matna" crop. The amount of Nitrogen in the Madrasi crop is indeed far higher than in the others; the proportion of Nitrogen in the several parts of the plant is high and so also is in the relative weight of green and dry leaves. In none of the four cases were the crops so heavy as at Poona. The crop of the Poona variety at Dumraon was only about half as heavy as a good one at Poona and the amounts of Nitrogen and Phosphoric acid in a good crop of cane at Poona may be said to approximate to at least 100lb per acre each.

STATEMENT No. 14.

The Amount of Nitrogen and Phosphoric Acid in the Sugar-cane Crop.

	DUMRAON EXPERIMENTS.				CAWNPUR EXPERIMENTS.			
	POONA VARIETY.		RED BOMBAY VARIETY.		MADRASI VARIETY.		MATNA VARIETY.	
	Per cent. Nitrogen.	Per cent. Phosphoric Acid.	Per cent. Nitrogen.	Per cent. Phosphoric Acid.	Per cent. Nitrogen.	Per cent. Phosphoric Acid.	Per cent. Nitrogen.	Per cent. Phosphoric Acid.
In fresh Cane	·025	·049	·028	·052	·046	·036	·054	·084
In green tops and leaves .	·153	·099	·22	·121	320	·117	167	·177
In dry leaves .	·425	·213	·336	·160	·550	·220	·353	·388
	Pounds per acre.		Pounds per acre.		Pounds per acre.		Pounds per acre.	
Weights of— Fresh cane	48,000		48,000		53,004		22,330	
Green tops	8,640		8,480		16,725		16,176	
Dry leaves	4,800		4,960		6,480		5,671	
	Pounds per acre. Nitrogen.	Pounds per acre. Phosphoric Acid.	Pounds per acre. Nitrogen.	Pound per acre. Phosphoric Acid.	Pounds per acre. Nitrogen.	Pounds per acre. Phosphoric Acid.	Pounds per acre. Nitrogen.	Pounds per acre. Phosphoric Acid.
In Cane .	12·0	23·5	13·4	25·0	24·3	19·1	12·0	18·7
Green tops	13·2	8·5	18·6	10·2	53·4	19·5	27·0	28·6
Dry leaves	20·4	10·2	16·6	7·9	35·6	14·2	20·0	22·0
	45·6	42·2	48·6	43·1	113·3	52·8	59·0	69·3

S. 61-64.

Conclusion.

Summary of results hitherto obtained.

15. We may now summarise briefly the results obtained up to the present on the subject of sugarcane—

(1) It is evident that the juice of different varieties of cane contain very different proportions of sugar; further that this proportion of sugar is not materially affected in any one year by any description of manure or its amount. This proportion of sugar in a cane may be affected seriously by a change of climate.

(2) The proportion of glucose in the juice of different varieties varies considerably; this proportion is increased, in some cases, largely during the boiling process; but that this "inversion" may be prevented in a great measure by the addition of lime. It is also probable that cultivators could easily be taught to "lime" their juice, if there were any call for it

(3) That during the boiling down process there is a loss of about 10 per cent. of the sugar which is in the juice operated upon, most of which is carried away in the scum. This sugar need not, however, be lost in the economic sense. It may be fed to cattle or (as at Poona) some at least of the sugar in it may be recovered.

(4) The amount of juice and consequently of sugar also which remains unexpressed from the cane, depends on the proportion of crude fibre in the cane. That, therefore, it is desirable to grow varieties of cane containing a low proportion of crude fibre. The amount of sugar remaining in the crushed cane may be as much as nearly one half of that in the cane or it may fall to as low a proportion as ⅛.

(5) The amounts of Nitrogen and of Phosphoric acid taken up by the sugar-cane crop will vary from some 40lb each (or less in poor crops) to about 100lb in such heavy crops as those grown at Poona.

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OXEN.

(CATTLE DISEASES.)

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Measures, legal and sanitary, adopted by European countries to oppose the introduction and spread of cattle plague, considered in relation to the circumstances of cattle disease as prevailing in India. By* DR. K. MCLEOD, *Bengal Medical Service.

Preliminary considerations.

A.—Before proceeding to discuss the particular legal and sanitary expedients adopted in Europe to guard against the invasion and spread of infectious cattle diseases, there are one or two preliminary considerations which have a most important bearing on the whole subject to be noticed.

Diseases spontaneously developed in, or imported into, an area?

I.—Are the diseases, against whose ravages it is sought to protect cattle, capable of spontaneous development in, or always imported into the country, province, district, or locality? If the diseases are produced by circumstances permanently abiding in, or apt occasionally to arise in any area of country, from whatever cause, the problem of protecting cattle residing within that area from their influence is entirely different and distinct from the question of preventing the importation of these diseases into the area. In the one case the question is,—What circumstances or causes prevail or arise in the area to give origin to disease? In the other case,—By what methods is disease apt to be introduced into the area? The difficulty of the first question is infinitely greater than that of the second. It is in fact an inquiry into the primary or immediate origin of the diseased conditions under consideration. We can, for example, in most cases easily ascertain how small-pox, measles, or scarlatina are imported into a locality or household, but it were a very different matter, if the idea of importation became from any cause impossible, to ascertain the local causes of an outbreak. It is comparatively easy—a matter of mere care and detail—to exclude an importable malady, when all the possible means of importability are known; it is utterly impossible until all the conditions of the development of an indigenous or endemic malady are known to prevent its occurrence.

Greater difficulty of dealing with an indigenous disease.

EUROPE. Origin of, "rinderpest" in the Steppes of Russia.

Now, with reference to Europe, universal testimony and scientific research have established that the "rinderpest" is indigenous to, or at the least always prevailing in, a limited area, namely, the Steppes of Russia, and it is unhesitatingly declared by every other country in Europe

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EUROPE.

that this formidable and fatal disease is not capable of spontaneous generation in their territories; but when it appears is always due to importation. The specific routes and means of importation are laid down, and instances of importation are abundant. Indeed, it is laid down as a preface to all regulation, as an indisputable principle of legislation on the subject—by all European countries except Russia—that is only by importation, and by no other means, the disease can arise; and even when the precise means of importation remain undiscovered, as in the case of England in 1865, this is rather attributed to a failure in the attempt to trace the evidence of importation, than to the possibility of the disease arising in any other way. All the laws and regulations of European countries proceed upon this axiom, and both reason and experience show that if the disease, when once imported, can be promptly and completely stamped out, there is nothing further to fear.

Imported into every other country of Europe.

Regulations framed on the belief of invariable importation.

Austrian regulations.

The preamble to the Austrian regulations distinctly states that the objects to be attained are—

(1) to prevent the plague from being introduced from the land of its home, and

(2) to destroy the imported plague as quickly as possible by destroying all the "vehicles and organs of the contagion."

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Importation doubtful.

In India we have not, unfortunately, a fundamental principle of this sort, clear and precise, to proceed upon. On the contrary, all is vague and dark. We know not, and we can never ascertain, whether our plagues were in the first instance imported or not. All we know is, that they spring up and ravage from time to time here and there. There is positively no evidence, and I can't see or conceive the possibility of obtaining any, to show whence and how these plagues arose. My own impression, derived from a close study of all that has hitherto come to light on the subject, is. that these diseases are *enzootic* in this country, spontaneously generated by conditions inherent in the soil and climate, and not owing to importation from without; that in fact we are in the position of the Steppes, and have these diseases as permanent residents in the country.

Cattle plague probably enzootic.

Permanently resident in the country.

We are seldom or never free of them. Year by year they break out, sometimes here and sometimes there. Whether originally of foreign origin or not, they have now established a firm hold; and if not universal within the area of Hindostan, are nearly so, inasmuch as if we take a certain series of years, few places will not have been visited by them.

Greater difficulty in dealing with it in consequence.

Our position is, thus, one of much greater difficulty than that of any European country, not even excepting Russia, for the greater part of that country is similarly circumstanced as regards rinderpest to other countries of Europe

Information imperfect.

In place of a single all-important leading principle of action there is doubt, imperfect information, and positive ignorance. Knowledge, thought, and experience have been accumulating on the subject in European countries since the beginning of the 18th century; in this country the subject has been overlooked till within the last few years, and I think I can safely aver that no single outbreak has been thoroughly and exhaustively investigated from its beginning to its termination. It is of the utmost importance to know what the precise nature of the disease has been and the precise loss of cattle; but, for purposes of sanitary legislation, the origin and progress of disease—its precise and minute history of rise and spread from beginning to end—are far more important desiderata.

Narratives of outbreaks a desideratum.

This can only be obtained by special investigation, and can only be exhibited by a detailed narrative of the particular outbreak from beginning to end. Such narratives are absolutely necessary in order to furnish clear

INDIA.

evidence of the behaviour of the disease as an epizootic on which to found preventive action. In Europe, as I shall show, preventive action has completely superseded medicinal appliances, and has in numerous instances proved successful. In this country, though from scraps of information obtained from various quarters certain leading facts have been made out, the natural history of plagues has not been studied with that particularity or detail which is absolutely necessary to render it a basis for action which may interefere with personal liberty or private as opposed to common interests.

Necessary for directing preventive measures.

Natural history of plagues imperfectly known.

Two facts, however, of exceptional importance stand out prominently among a host of conjectural or unproved assertions. They are :—

Two facts well determined.

1st.—That a particular area of country, be it a province, district, subdivision of pergunnah, is only attacked or invaded occasionally, that is, that although these diseases are apparently permanent in the country, they are not permanent in any particular segment of it.

Occasional invasion of a particular locality.

2nd.—That the diseases are contagious and infectious.

Diseases contagious.

I have elsewhere adduced satisfactory proofs of these statements, but it is still unascertained in what manner these diseases, universally believed to be contagious, effect their entrance into a sound locality and how they spread in it. These points can only be determined by closely watching and following up the disease; but, given an infectious disease or diseases, and a series of areas in which they do not reside permanently, the problem of prevention and limitation is placed on a more promising footing, and the object to be accomplished becomes clear, namely, to prevent the invasion of a sound area by a highly contagious disease. The measures by which this object is to be attained will then depend upon the circumstances of the country, its inhabitants, and cattle. This leads me to the second consideration, which I would dwell shortly upon.

The problem of prevention stated.

II.—The purposes for which cattle are employed, and the manner in which they are bought and sold, housed, grazed, herded, moved about and fed, in the fulfilment of these purposes, are most important considerations, as affecting, *1st*, the modes in which they may contract contagious diseases; and, *2nd*, the laws or rules which may be imposed to prevent or limit that result. Here again, between Europe and India, there is a most fundamental difference. In Europe cattle are used primarily for *food*. Subordinate to this is the use of their skins, horns, tallow, etc. Next in importance is their use as givers of milk and the various dairy products derived from it; and *3rdly*, in some countries they are used as beasts of draught and burden.

Purposes for which cattle are used, and their life and treatment as affecting—liability to disease, and the laws to prevent these.

The use of cattle for food involves—

(1) a constant *destruction* of them, the number destroyed depending upon the number of consumers;

(2) a systematic *breeding* for the purpose of supplying the constant demand,

This necessitates herding on a certain area, for the greater number that can be produced on a certain area the more profitable. It also involves association and contact, which, however, need not extend beyond the single area or farm. It is easy to see how this particular condition favours the spread of infectious disease.

Herding.

Association.

3. *Fattening.*—Most commonly the farm on which breeding is most extensively conducted does not supply sufficient provender for fattening. Accordingly cattle are transferred from one farm to another, and from one proprietor to another, for this purpose. This takes place through the medium of *lean stock markets*. Cattle here come from different points, are associated closely for a time, and then dispersed to other places. This is a most potent means of spreading infectious disease.

Fattening.

Movements. Markets.

OXEN.	Measures adopted to oppose

INDIA.

Conveyance. Markets. Means by which infectious disease may be spread.

4. *Conveyance* from the place of breeding or fattening to the place of consumption. This again involves change or changes of owners, market or markets (*fat stock markets*), mixing, dispersing, and association. No better means could be devised for spreading infectious disease than the series of changes—forming and splitting up of flocks, herding, driving, and markets which occur as cattle pass between the breeder and butcher; and even here the danger does not end, for after slaughter and quartering there remain the skins, horns, and offal, which may contain the germ of infection, and which are subject to sundry changes of hands and place.

Importation. Markets, etc. Importation of products.

5. If the supply of any district or country is not equal to the demand, then *importation* becomes necessary; with it markets, changes of owners, etc, etc. Thus disease is brought into a country and dispersed in it. Moreover, for particular industries importation of products may be necessary, affording another channel for importation of disease.

Modes of conveyance may spread infection.

The circumstances above detailed not only facilitate contact of cattle, and so conduce to the spread of disease, but the very means and paths of conveyance impart additional complications and conveyance by sea, rail and road, through pastures, commons, bye-ways and streets may become the means of sowing disease broadcast over a large area by means of contaminated discharges and dejections.

Dairy use implies herding, stabling, commerce.

The use of cattle for dairy products involves (1) *herding* and the use of common pasturage; (2) *stabling*, more particularly in towns in this latter case overcrowding and sundry unsanitary conditions may prevail; (3) *buying and selling*, importing and exporting.

Draught use implies movement, association, buying and selling.

These afford facilities for the spread of disease, but in a much less degree than the use of cattle for food. The use of cattle for draught and burden involves—

(1) movement from place to place;
(2) association and dissociation;
(3) buying and selling to a still more limited extent.

Use of cattle for food, facilitates spread of disease more than any other cause.

The principal interest to man and the principal modes of extending infectious disease attaches then to the use of cattle for food, and this it is that in Europe at once stimulates—

(1) the great traffic in cattle;
(2) the easy spread of disease;
(3) the stringent regulations to prevent the advent and spread of disease into any territory.

India, contrasted with Europe.

India presents us with an exact contrast to the state of matters in Europe. Here the uses to which cattle are put are in order of importance:—

Cattle used for draught and burden, dairy, food.

(1) Draught for agricultural purposes.
(2) Draught and burden for purposes of conveyance.
(3) Milk and dairy products, butter, *duhi*, and *ghi*.
(4) Human food.
(5) The only products used are, (*a*) skins for leather, (*b*) dung for cooking and *lepbing*.

Products.

Information sketchy.

I shall touch on these in their order; but it is obvious that the more exact and exhaustive the information on these heads, the greater the power in prescribing sanitary and preventive measures. The information I possess has been cursorily and incidentally obtained, and is subject to correction; but I could not too strongly urge the necessity of a systematic enquiry into the conditions of existence and treatment of cattle as a necessary preliminary to any action in the matter.

INDIA. Employment in agriculture.

1. The use of cattle for agricultural purposes involves them in conditions which vary with—

(*a*) the character of the country, dry or wet, inundated or the reverse;
(*b*) the kind of crops cultivated; and
(*c*) the season of the year.

No systematic slaughter. Demand for cattle less.

It is obvious in the first place that there is no systematic destruction, nor any loss beyond that caused by wear and tear and disease. Demand for new stock will therefore vary with the loss from these causes, and can seldom or never habitually equal the demand when animals are systematically destroyed for food. Supply, which means breeding, movement, markets, importation, etc., will therefore be less. If, however, the traffic in cattle is necessarily less, the village system which obtains all over the country affords a means of promiscuous and universal communication among cattle.

Village system. Promiscuous communication.

The cattle of one village are always herded and pastured together, though housed separately. Where large *maidans* exist between several villages, the herds of these constantly come into contact. During the cultivating and gathering seasons (spring and harvest) the cattle are driven along the same roads and paths, and meet in the same fields and *bhíls*. Communication is absolutely unimpeded, and even more so than in Europe, where separate farms impose a sort of isolation. The only isolation existing in India is in inundated districts and tracts during the rains, when every village is an island, and cattle are either housed and fed on rice, straw, or pastured in herds on some pasturage which happens to be above water. A practice prevails in some places of herding the cattle of one or several villages, and sending them for pasture to some distance when work is not urgent. In other cases the farm of a village or family may be at some considerable distance from the *barí* or home, and at sowing and reaping times the cattle are driven thither and housed together in considerable numbers.

Communication perfectly free.

Sending cattle for pasture in herds.

Hâts.

All the buying and selling is done in the *hâts* so numerous all over the country. Cattle are driven to them without rule or restriction, and may be sent to half a dozen different *hâts*, or the same over and over again until they are bought.

Disposal of carcasses.

When cattle die they are thrown into a stream, *khal*, or river, or upon the open plain. The hide and horns may or may not be removed by *mochis*, but the carcass becomes a prey to crows, vultures, jackals, and dogs. It is of importance to note that crows and dogs may come in contact with living cattle. Crows frequently settle on live cows and pick their nostrils, ears, or tails.

The foregoing imperfect sketch of the circumstances under which cattle exist in agricultural districts will illustrate sufficiently—

(*1st*) the enormous facilities for the spread of infectious diseases; and
(*2nd*) the difficulties to be overcome in prescribing sanitary restrictions.

Disease may easily spread, and restriction is a matter of difficulty.

Use for burden involves movement, contact.

2. The use of cattle for burden involves—

(*1st*) constant movement and change of place;
(*2nd*) various and incessant contact with other cattle.

I need not enlarge on this head, for the facilities which the use of cattle for draught and burden (and in this country they are almost the only beasts of burden) afford for the importation and spread of disease are sufficiently obvious.

INDIA.

Dairy use. Herding. Housing.

3. The use of cattle for dairy purposes involves in most cases—

(*1st*) herding and common pasturages ;

(*2nd*) housing in considerable numbers ; both these conduce to spread disease.

Use for food.

4. Cattle are only used for food on a large scale in Calcutta, and places where European troops reside.

Cattle droved.

The animals are recruited from a wide area by agents or drovers, collected into herds driven along roads, and finally sold to the commissariat and to butchers.

Disease by this means may be scattered far and wide.

Hides.

5. The trade in hides is mainly conducted by *mochís*, and unless the skin is destroyed by some eruptive disease, it matters not whether the animal have died of infectious disease or not. This unrestricted trade in hides may spread the disease.

Dung.

Lastly, cow manure, which in cases of cattle plague contains the contagious principle,—whatever that may be—is, in this country, collected, caked, dried on the walls of houses, and applied to the floors once a day or oftener.

Importance of cattle as food producers.

If in Europe the importance of cattle as an article of food compels the attention of rulers to their diseases and the prevention of them, in this country their importance as the only available means of growing food and conveying agricultural and other products gives this subject a still greater claim to the attention and concern of Government.

Habits, interests, and prejudices of population.

III.—The habits, interests, and even prejudices of a population are important considerations in coming to a conclusion as to imposing restrictions which may interfere with either. This is a general principle which I need not illustrate, and only state here for the sake of completeness.

Difficulty of the matter of restriction.

The foregoing heads comprise all the conditions which govern the problem of checking the origin and spread of cattle plague. A thorough knowledge and due weighing of *all* the points which they include is necessary to come to a just conclusion. In this country nearly all the labour upon which the life and prosperity of the natives depend is performed by means of cattle, and it is a matter of the greatest difficulty to adjust the balance between, on one side, the evils caused by diseases, and good to be obtained by restrictive measures, and, on the other, the evils which may be caused by what interferes with habits, prejudices, private interests, nay, the very means of bare subsistence of the natives, so that the greatest good may ensue.

The greatest good.

The greatest good in this case to be expected is—the greatest possible diminution of the evils of cattle plagues, with the least possible interference with the private interests and industrial pursuits of the people.

Measures employed in Europe.

B.—I shall now proceed to examine in detail the various sanitary expedients which European nations have adopted to thwart the invasion and spread of cattle diseases, considering in succession the applicability of each to India.

Measures to prevent entry into a country. Do not apply to India.

I.—THE MEASURES ADOPTED TO PREVENT ENTRY INTO THE COUNTRY ARE—

(1) quarantine, and (2) inspection.

These measures are applicable only to an area of country in which the disease *does not permanently reside.* They do not, therefore, apply to India as a whole, because there is every reason to believe that these diseases do permanently reside within its boundaries.

Until we know more of the precise place of origin and laws of progress of these diseases, it is impossible to say whether particular areas, districts,

or provinces might be preserved by interrupting the progress of an invading disease.

EUROPE.

In Europe the data are clear. Plague is bred in the east and south-east, and marches with the tide of commerce or war, north, south, and west. It is simply a question of special arrangements, special establishments, artificial hindrances to importation and intercourse until by means of careful inspection the absence of disease has been ascertained, and by permitting time for its development, proved.

Quarantine in Germany.

The quarantine rules of Austria and Prussia are very precise and strict. They vary, however, with the actual absence or presence of neighbouring disease. In the latter case, precautions are redoubled, and the period of detention of cattle on the frontier lengthened. In great emergencies importation of cattle or products is altogether prohibited, as in France and Belgium in 1866, and into Ireland and Lewis in 1865. England possesses a natural barrier in the German Ocean, and careful inspection at the ports of embarkation and debarkation, with powers of preventing either, or ordering the slaughter of cattle, are principally relied on. Slaughter of cattle at the port of debarkation, and special foreign cattle markets have been proposed to the same end. It is obvious that all depends on the *perfection* of the means employed both in power and application.

Importation

Inspection.

Foreign cattle markets.

Quarantine not applicable to this country.

No line can be drawn.

In India a *habitual* quarantine system is not indicated, nor indeed practicable ; and so innumerable are the paths and channels of communication that habitual inspection is equally impossible.

Nothing has as yet appeared in the history of these diseases to show where, over the whole country, a line can be drawn, until a definite place or places of origin can be shown, or a definite line or lines of travel, the idea of quarantine is simply absurd.

II.—MEASURES ADOPTED WHEN THE DISEASE HAS APPEARED, BUT NOT SPREAD WIDELY.

Measures adopted on appearance of disease

Giving notice —importance.

By owner or attendant of cattle to police or civil authorities.

(1) *Giving notice.*—This is a matter of primary importance, and absolutely necessary, when it is the duty of the executive to adopt certain measures. It is still more important when these measures are found by experience to be more efficacious when the disease first appears, the cases are comparatively few, and the infected area limited. The notice is to be given by the proprietor of the cattle, or by the attendant or conductor to the police or civil authority of the commune or district. Severe penalties are in most countries of Europe attached to the neglect of this all-important step.

Penalties. Causes of neglect.

Neglecting to give notice to district authorities might arise from (1) simple negligence, (2) designed concealment in order that an owner might sell his cattle, or to avoid the trouble and worry of restriction and special arrangements. These motives are of the selfish kind which prompt men to consider their own individual interests before the public weal. The precise nature of the "duty of giving notice," will vary with (1) the circumstances under which notice is expected to be given. It is obviously out of the question to expect that, at any rate in this country, every case of sickness or death amongst cattle should become the subject of formal report. In most countries the matter is left to the intelligence of the inhabitants, who, under penalty which may attach to their neglect of reporting the existence of "the plague," are left to judge of what may appear "suspicious attacks." In Prussia the matter is more rigidly defined. "It is considered suspicious if at any place two beasts

Circumstances under which notice should be given.

Rule in Prussia.

OXEN. | Measures adopted to oppose

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died within fourteen days out of a stock of about fifty head, or three or more out of a larger stock." When the plague is known to rage in a neighbouring country or district, notice of the "smallest trace of sickness" is enjoined. In ordinary circumstances, the occurrence of suspiciously numerous cases of sickness or death would justify or suggest giving information · *when the plague rages,* one case of sickness or death would be sufficient warrant for notice

In ordinary circumstances. When plague rages.

The area and authorities.

(2) THE AREA AND CORRESPONDING CIVIL AUTHORITIES WITHIN AND TO WHICH NOTICE IS TO BE GIVEN.

Report in ordinary circumstances

SAXONY. AUSTRIA. RUSSIA.

In ordinary circumstances, the Police divisions of a country and the corresponding executive authorities naturally point to the limits and direction within which and to whom notice, information, or report should proceed. Most countries direct notice to be given to the Police or Magistrate of a district. In Saxony notice goes to the Pest Commissioner, in Austria to the Cattle Plague Commission; while in Russia *information is to be given to the heads of villages, through them to the rural police, who transmit to the superior local authorities*

Report in extraordinary circumstances ENGLAND.

In extraordinary circumstances the country may be divided, as in Austria, into cattle plague districts or special areas with corresponding special officials to whom notice is to be given In England the duty of giving notice is left to the sense of the people, and the Veterinary Surgeon or special Inspector will be the first to obtain it, thence the information proceeds to the civil authorities (Magistrates) or to the Privy Council

The purpose of giving notice. Information Investigation, Special agency

(3) THE END TO WHICH THE GIVING OF NOTICE CONTRIBUTES.

Whatever that end may be, whether (*a*) for mere information, (*b*) for ordering investigation, (*c*) appointing special agencies or arrangements for treating the sick cattle or exterminating the disease, the importance of obtaining earliest information cannot be overrated. In this country, most commonly the disease has gained complete possession of a district or sub-division, or is actually on the decline, before the civil authorities are aware of its existence, and I am satisfied that many an outbreak occurs which is not heard of at all It is thus impossible to trace the rise and progress of the disease, or to bring special investigation or treatment to bear upon it until it has acquired such a hold of a large area that it is next to impossible either to find out whence it came and how it proceeded, or to extinguish it, or limit its progress In Veterinary Surgeon Thacker's report on the murrain of Madras, several instances occur of his being informed of a disease among cattle in a certain locality, and finding on proceeding there that it had passed away! Many obstacles exist to receiving early notice of outbreaks in this country, principal among them—1—the apathy, suspicion, and prejudice of the people: 2—the absence of that governmental or police discipline which exists in countries of the continent of Europe: 3—the small number of civil officers compared with the vast population: 4—the large areas of districts: 5—the want of public feeling as opposed to private selfishness on the part of landholders.

Delay in India Consequence of delay. Madras. Obstacles to receiving early notice

Early information particularly necessary in India. Channels of Information

If anything is to be learnt or done with reference to cattle plague, and in this country the plan of action remains to be determined on the basis of the behaviour and nature of the disease, early information is a *sine qua non.* The channel of information would be—1—the heads of villages or zamindaries: 2—the Police: 3—the Magistrate.

2. *Inspection.*—This involves a special skilled agency, and whereas the last paragraph described a spontaneous system of information proceeding through the ordinary paths of official communication, or received by a special individual or department, this contemplates a definite means of seeking for information The latter may or mav not be associated with the power of ordering measures either already laid down by law or devised to meet circumstances as they arise.

ENGLAND. Inspection. A voluntary seeking of information. Coupled with authority to act.

In England inspection vested with powers defined by Act of Parliament and orders in Council is the chief means employed against the cattle plague. Inspectors appointed by the Clerk of the Council for the Metropolitan Police district, by the Justices for petty sessional divisions, Mayors of boroughs, etc., are entrusted with powers of visiting, inspecting, killing, disinfecting, secluding, etc. These Inspectors are in most cases Veterinary Surgeons.

Inspection the principal agency employed.

In Prussia an Inspector of sound cattle and a Superintendent of sick cattle are appointed, who, under the direction of the civil authorities, examine cattle sound and sick, and carry out the laws and regulations defined by Government.

PRUSSIA. Inspector of sick and sound separately employed.

In Austria local Inspectors are appointed for examining herds, issuing passports, examining cattle, granting certificates, and in addition "guards" are entertained for carrying out quarantine and other sanitary regulations.

AUSTRIA. Inspectors. Guards.

In France and Belgium inspection is performed by the Police, assisted by Veterinary Surgeons.

FRANCE and BELGIUM.

In Russia, also, the Police and Veterinary Surgeons are associated in the duty of inspection.

RUSSIA.

In Saxony the Police and Pest Commissioner or Commissioners are the active agents in investigating disease and applying remedies.

SAXONY.

In every country special skilled agency is thus recognised and employed for the two-fold purpose of investigating diseases, and directing the application of remedial measures.

Special skilled agency employed in all countries.

These are the two main objects of special skilled agency, and the amount of such agency will depend on the circumstances of the country or time. It is evident in the first place that the agents must be competent, that they should possess a sufficient knowledge of cattle diseases and their treatment, so as to be able satisfactorily to investigate and describe the one and apply the other: *2ndly*, that they should be vested with certain defined powers of interference, or better, perhaps, should, as skilled advisers, be able to command and put in motion the ordinary civil authorities; and *3rdly*, that when disease abounds their number should be increased.

According to circumstances. Must be competent men. Vested with powers or able to command authority. Increased when disease increases.

In this country, except the employment of one Veterinary Surgeon for a presidency or province, nothing in this direction has yet been done: yet seeing that little can be expected from the intelligence or public feeling of the inhabitants, and that already existing establishments have duties enough and to spare assigned to them, special agency is peculiarly indicated.

Special agency necessary in India.

If anything is to be systematically learnt or done with reference to cattle diseases, the whole time and attention of qualified men is needed, and as yet such men cannot be found. The experience of Madras proves that one man's services are utterly inadequate to the demands of an extensive area. All other countries have their Veterinary Surgeons: in this there is no native who has the smallest pretension to a scientific knowledge of the diseases of cattle, and European Veterinary Surgeons are few and their services expensive. The proposal of Veterinary Surgeon Farrall, which has, to a certain extent, received the practi-

Skilled men not to be had. One man insufficient for a large area. Natives must be educated. Proposal of Veterinary Surgeon Farrall.

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cal sanction of Government, to have natives properly instructed in veterinary medicine is therefore a necessary preliminary to any step in the direction of bringing skilled agency, to bear on the investigation or management of these diseases.

Experience of England.

Notice. Information. Disastrous consequence of inefficiency. Suitable agents must be first obtained

The experience of England shows, *1st*, that the earliest notice of the existence of the plague came through Veterinary Surgeons in communication with a special department; *2nd*, that the most reliable information of its progress, peculiarities, and spread was obtained by the same means; and, *3rd*, that the incompetence of many of the men appointed, for the demand exceeded the supply, was a most potent hindrance to efficient dealing with the plague While, therefore, the considerations I have adduced above would strongly point to the advantages of special agency, the absence of suitable agents is the first thing to be taken into account, and until such exist, the ordinary executive police agencies in existence must be employed, assisted by any medical advice which civil surgeons or native doctors can give.

Human and veterinary practice associated in Austria. Instructing native doctors in veterinary medicine suggested.

In Austria both human and veterinary medicine are learnt and practised by the same individuals, and it is worth considering whether our native doctors might not obtain in addition to what they are already taught a sufficient amount of instruction in the diseases of domestic animals to render them capable of employment in cases of emergency, and until a special veterinary department exists, the medical department might, as it has, to a certain extent, already done in the person of civil surgeons, direct investigations, receive and compile reports, and generally fulfil the functions performed by *Pest Commissioners* in other countries.

Provisional separation.

3. *Provisional separation of cattle.*—This measure is adopted previous to the formal examination and identification of the disease, and consists in carefully keeping sick cattle separate from sound.

Prussia.

In Prussia the duty is minutely defined. The suspiciously sick are forthwith to be isolated, sound cattle removed, and the stable locked up. No beast is to be used for draught or field work.

In other continental countries similar precautions are enjoined.

When the case of sickness is suspicious, and the system of isolation is practised and enjoined, this precaution is obviously a most necessary one. It proceeds on the assumption that the disease is *infectious*, and the seclusion and separation cannot in this case be too complete.

Identification of disease. Importance.

4. *Identification of the disease.*—It is plainly of the highest importance, as soon as possible, to determine what the disease is, as on this will depend the ordering or not of future measures.

Conducted by civil authorities and Veterinary Surgeon. Dissection.

Accordingly, in continental countries the civil authority or authorities to whom notice is given are enjoined to associate with themselves a Veterinary Surgeon and to proceed to the spot to acquaint themselves with the exact state of matters. Not only must the sick animals be carefully examined, but any animal that has died is directed to be examined and in Saxony and Austria a diseased animal may be killed for that purpose, or disinterred as in Russia. For identification a skilled observer is obviously required, and the sooner it is done the better. In this country this duty will ordinarily, in the absence of other skilled advice, fall to the Civil Surgeon. In order to assist in this important duty it is highly desirable to diffuse among officials and population a sufficient amount of information as to the nature and features of infectious or epizootic cattle diseases, to enable them to identify these, and to distinguish what is harmless from what is dangerous as regards other cattle.

Skilled observer required.

Instruction of officials and population.

This is done by concise descriptions appended to most of the instructions issued by European Governments. In this country all that could be done in the circumstances has been already done in the way of disseminating information, and there shou'd be no difficulty in recognising the nature of *epizootics*. The instruction of the population in this matter will also materially contribute to stimulate attention and prompt the giving of notice

In European countries. In this country.

5. *Proclamation and report*—The disease identified, the next step is to (1) apprise all the inhabitants of the district of its existence; (2) acquaint the higher authorities; and (3) either directly or indirectly warn neighbouring districts.

When special agencies exist, their attention and services are now put in request.

Proclamation and report. Warn inhabitants. Acquaint authorities. Warn neighbouring districts. Special agency.

6. *Isolation of sick and separation of healthy.*—Immediate separation of sick and healthy is the first measure enjoined. In most cases the sick are left in their stables, and the healthy removed elsewhere. This is the rational proceeding, and should be repeated as often as sickness re-appears. The disposal of the sick will depend on the rules in force or the will of the Inspector, Commissioner or Commission, or responsible authority. The separation of the healthy must be complete—separate stables, separate pastures, separate attendants—and, if the herds are large, it is found convenient and useful to split them up into sections completely separate from each other. In a country divided into farms this proceeding is comparatively easy; but where, as in this country, there is a community of pastures, etc., separation must be a more difficult matter. In this case the people must combine to carry out the idea of seclusion of sick and separation of sound cattle. The precise means can only be indicated by one ascertaining the circumstances of the case on the spot. Removing the sick and leaving the sound in their old stables and pastures has been advised and practised, but it only subjects the sound to any contagious influences which may reside in the locality or may have proceeded from the sick.

Isolation of sick and separation of healthy. Sick left in their stables. Healthy removed. Disposal of sick. Separation must be complete. Splitting up herds. Difficulty of common pastures. Removing sick objectionable.

The distance to which the sound are removed will depend on the space at disposal, but the greater it is the better; in Prussia quarantine stables are ordered, to which suspicious cases are sent.

7. *Isolation of infected areas.*—This is done on the continent by means of sanitary cordons, circles of observation and restriction drawn round infected areas by means of guards, police—military or special—by which *all communication*, except what is absolutely necessary, is interrupted. If this system is possible, and thoroughly carried out until the disease has spent itself in the locality or been otherwise stamped out, nothing can be more effectual, but the sacrifices involved are most serious. Personal liberty is compromised and commerce impeded, because no individual nor article can be allowed to go out of the area nor anything received into it, except what has been deposited by one set of persons and received independently by another. Even clergy, medical men, and midwives must change their clothes and disinfect in passing or re-passing the circle.

Isolation of infected areas. Sanitary cordons. All communication suspended. A very effectual measure. Sacrifices. Liberty. Commerce.

Without entering into a discussion, I have no hesitation in saying that this system is perfectly impracticable in this country.

This system impracticable in India.

8. *A census of cattle* is a part of the cordon system and occasional inspection to ascertain that no beast has been removed. In Austria the process of making the census is minutely laid down so as to prevent conveyance of infection from sick to sound; and the census of neighbouring districts is also to be made, so as more efficiently to control the movements of cattle.

Census of cattle, with occasional inspection. Austria. Census of neighbouring districts.

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OXEN.	Measures adopted to oppose

Stopping markets and cattle movement. Recommended by English Cattle Plague Commissioners. Applicable to India.

9. *Stopping of markets and all movements of cattle within infected area.*—This measure is a part of the cordon system on the Continent and in England, is left optional with the magistrates of counties in session. It constitutes the principal recommendation of the Cattle Plague Commissioners, after taking minute evidence on the subject from all persons concerned. When cattle are used for food, it is obviously a more severe measure than when they are used for draught or agriculture. I can see no difficulty in prescribing a measure of this sort in this country, prohibiting the driving of cattle to *hâts* within an infected area during the prevalence of cattle plague.

Purchase of cattle.

If agricultural operations are not in progress, there can be no immediate need for purchasing; and if agricultural operations are in progress, the purchase of cattle to supplant those which die might be managed by a special agency under precautions.

Stopping movement of gharries. Difficulty.

Stopping the movements of gharries, in other words, the conveyance of produce, is a more serious consideration. If boat conveyance is possible, the difficulty is less, or vanishes, but otherwise, it becomes a matter of serious doubt whether movements of draught cattle can be, under any circumstances, prohibited in India without prejudicing the interests of the people to an extent not compensated by the saving of cattle effected.

Precautions. Commissariat supply.

In times of severe disease, however, the routes of movement, the housing of moving cattle, etc., might be so ordered as to minimise the risk of conveying disease. It is also worthy of consideration whether exportation for the purpose of Commissariat supply should not be prohibited from infected areas.

Defining the infected area. Germany.

For the purpose of this and other measures, it is of primary importance to *define the infected area*. In Germany it is accurately laid down —a radius of three German miles from the centre of infection. The accuracy of definition will obviously depend on the accuracy of information, and the infected area should at the least contain all the seats or centres of disease.

Special definition of area.

If the area coincides with the ordinary police divisions it simplifies the matter considerably; but the disease may prevail over portions of two adjacent pergunnahs or districts, in which case a special definition will be necessary.

Slaughter; rationale.

10. *Slaughter.*—The rationale of this measure is, that by destroying all the sick and suspicious cattle the contagium or contagious principle of the disease may be summarily got rid of.

Efficiency of this measure.

It is the sharpest, and in certain circumstances the most efficient, arrow in the quiver of remedial measures.

Object.

Its object is by the voluntary sacrifice of a few beasts to save a district, province, or country from being universally seized on by the plague.

Austria.

The laws of some countries are very pronounced. The Austrian regulations put the matter in a clear and sensible light.

Circumstances in which slaughter is advisable.

"The efficient means of quickly annihilating the plague in a locality are various, according to the greater or lesser spread of the malady at the time of its first appearance. If the result of the recent census of livestock shows that only a few cases have sickened with the malady in the place whence no further spread abroad is to be apprehended, and that consequently the plague may be expected to cease there by removing quickly the diseased and suspected beasts from the place, and proper cleansing of the stables, then it will be expedient to kill all such beasts, or, as the saying is to *use the club.*"

PRUSSIA.

Prussia says:— "It is especially of the utmost importance, and is most sure to contribute to the prompt extinction of the plague, that every beast attacked at the very commencement of the malady be forthwith killed and put away, without taking too much trouble in examination in the quarantine stables."

SAXONY. FRANCE, AND BELGIUM.

Saxony, France, and Belgium proceed on similar principles.

In England Inspectors are empowered to "enter and inspect all premises within their district in which any animal (including neat cattle, sheep, goats, and swine) may be found, to seize, slaughter, and bury animals diseased, and to disinfect the premises, and to order the separation of animals suspected of being diseased." ENGLAND.

From those extracts the circumstances under which slaughter is either necessary or desirable will be easily seen.

1. The disease must be *an infectious disease, not developed in the locality, nor due to conditions permanently or even temporarily resident there.* Disease must be infectious.

2. The area infected must be limited, and the number of animals affected (sick) or which have come in contact with these (suspected) few. Area must be limited.

3. All the animals capable of imparting infection (sick *and* suspected) must be slaughtered. Sick and suspected must be killed.

4. All other means by which infection may be spread (hides, horns, offal, dung, litter, fodder, halters, stables, etc.,) must be destroyed or disinfected. Hides, horns, etc., must be destroyed.

5. All other means (isolation, separation of sound cattle, etc.,) for preventing the spread of infection must be simultaneously employed. Other measures simultaneously adopted.

By the observance of *all* these precautions the contagium may, and often has been destroyed, and a large loss of cattle saved. After the disease has extensively spread, and numerous centres of a large area have been developed, destruction of cattle becomes a measure of extremely doubtful propriety. Circumstances in which killing is of no use.

Even in Austria this is admitted, and in Aberdeenshire in 1865 this measure was unsparingly adopted, with no satisfactory result. In the Netherlands an official report states that slaughtering will not always be sufficient to eradicate the disease, as by this means no recovered animals, whose value, as not liable to a second attack, is so much greater, remain; killing is, however, recommended when the disease first appears, and cases are few. Value of recovered cattle.

In Russia, Bavaria, and districts where cattle plague is habitually or frequently present killing is not practised. RUSSIA. BAVARIA.

Where cattle are used for food, and means of rapid conveyance are available, killing can be more extensively practised without loss, by establishing a system of dead meat markets. Dead meat markets.

Looking to the circumstances of this country, and the uncertainty as to the origin of the disease, killing, as a measure for general or even occasional adoption, cannot be thought of. Killing not advisable in India.

Perhaps, when the behaviour of the disease has been better ascertained, killing may be practised when its appearance at a new centre can be promptly ascertained.

II. *Burial.*—This is prescribed in the regulations of every country. Burial.

(*a*) The *subjects* to be buried are all cattle dying of the plague and the sick slaughtered. The *suspected* are permitted to be used as butcher meat under certain precautions. Subjects to be buried.

(*b*) The *place of burial* is specially pointed out in the Prussian regulations. It is to be a piece of waste land, far removed from cattle and human habitations, and, if possible, adjoining the quarantine stables. A piece of land may be taken up for the purpose by the authorities, compensation being afterwards paid to the owner. This place is to be railed in, and not used for any other purpose for two years. Place.

(*c*) The *mode of burial* is also fixed. Animals must be conveyed, not dragged, to the place of burial. The conveyance must be drawn by horses. The graves must be at least six feet deep, the carcasses are to Method. Conveyance.

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	be covered with quicklime, the skins slashed, and all the earth removed out of pits put over them.
Persons who bury.	(*d*) The *persons who bury* are not to have any communication whatever with live cattle, and are to be specially retained for that purpose.
	This precaution of burying the dead of cattle plague is of the last importance, and should be scrupulously enjoined in this country, where carcasses are either thrown into a river or left to be devoured by animals. The contagium in either case is sown broadcast. It is hardly necessary to add that neither the meat nor produce of diseased cattle should be in any way used.
Disposal of dung. Buried.	12. *Disposal of dung.*—The dung of infected stables is directed to be buried in deep pits. This is a point of great importance, as the dung is believed to contain the contagium of the disease.
In India.	It is more difficult to deal with the dung voided on pastures; and in this country, where cow-dung is collected and used for plastering walls and floors, the difficulty of avoiding this source of infection is greater. The Austrian regulations direct that the dung of sick animals in transit should be buried.
Confining sick in stables.	If the sick are confined in stables on the earliest appearance of symptoms, the difficulty of disposal of dung is much lessened.
Disposal of fodder, etc. Burnt. Pastures.	13. *Disposal of fodder and litter.*—The discharges escaping from the eyes, nostrils, and mouth contain the contagium, and infect the straw, etc., in the stables. This should be burnt. When discharges fall on pasture no remedy exists, except to confine the sick and remove the healthy.
Halters. Burnt or disinfected.	14. *Halters and stable gear* should either be burnt, if of small value, or disinfected, if more valuable.
Stables.	15. *Stables* are directed to be carefully disinfected, and kept empty for periods varying from two weeks to two months, in different countries.
Dogs.	16. *Dogs* are to be tied up, or killed if ownerless.
Poultry.	17. *Poultry* should be confined, and by no means allowed to frequent stables.
Sheep, goats, etc Separated.	18. *Sheep, goats, swine, etc.,* are to be carefully kept apart from diseased cattle, because they are not only capable of taking the cattle plague themselves, but are still more so of conveying the disease from sick cattle to sound.
Duration of restriction. Three or four weeks after last fatal case.	19. *Duration of restrictions.*—It is usually considered necessary to continue the foregoing arrangements and restrictions for three or four weeks after the last fatal case.
Conditions under which foregoing measures are effective.	The foregoing measures form items of a complete system by which it is endeavoured to nip an outbreak of imported disease in the bud. This has repeatedly been done in France and Germany. In order that it may be done, it is necessary (*a*) that information should be promptly and precisely given; (*b*) that the measures to be adopted should be exactly laid down; and (*c*) that the agency by which the measures are to be carried out should be *defined* and *available*.
Inoculation and medical treatment.	I have not in the foregoing said anything of inoculation or medical treatment, because neither of these means fall under the scheme of isolating and destroying all the existing contagium; they rather tend to its dissemination.
Proclamation of sanity of area.	Finally, as an infected area should be proclaimed, so its freedom from disease should be officially made known.

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III.—MEASURES ADOPTED WHEN THE DISEASE HAS SPREAD EXTENSIVELY OVER A COUNTRY.

Measures adopted when disease has spread.

Hitherto I have assumed the existence of one or a few centres of infection and a small area; now I contemplate a multiplicity of centres and an extended area. The subject may be looked at in two ways; (1) the infected area may be considered with relation to surrounding healthy places; and (2) included sound areas may be considered with reference to the surrounding infected area.

Surrounding sound localities. Included sound localities.

1. In order to prevent spread beyond the area, it is necessary to hinder the export of contagious material by cattle, products or other agencies to surrounding healthy localities. The same method already indicated, but on a larger scale, will be necessary; more particularly separation of sound from sick, burial of litter, and destruction of contagium in every form, together with as much limitation of the movements of men and cattle as possible.

Export prevented.

2. Within the infected area, three objects are of paramount importance: (*a*) to save as many sound cattle as possible from infection; (*b*) to procure the recovery of as many sick as possible; and (*c*) to get over the disease as quickly as practicable.

Objects to be attained within infected area.

By common consent, killing is considered improper in such circumstances. If sick and suspected animals are all killed, the destruction of cattle must be enormous, and the prospect of gaining a greater advantage to compensate, namely, immunity of a large area from attack, becomes less in proportion to the extent of the area already infected. The only slaughter at all justifiable in such cases is the slaughter of moribund animals, in order to get rid more quickly of a loathsome, pestilent object.

Killing improper. Killing moribund cattle.

If any village, farm, or section of the infected area remain healthy, efforts must be redoubled to prevent the entry of contagium. In such circumstances the most strict and severe cordon is appropriate and necessary, coupled with precautionary measures, disinfection, careful feeding, watering, etc. If a river comes from the infected localities, cattle should not be allowed access to it.

Strict measures of isolation necessary to save included sound area.

Over the infected area, strict separation of sick and sound, isolation of sick, parcelling out of herds, destruction of contagium, and disinfection are the main points insisted on.

Measures to be adopted throughout infected area.

Medical treatment now obtains sanction with the object of preserving as many alive as possible; but it should, if possible, be applied in special hospital stables carefully isolated. The function of medical treatment refers to individual cases, and it cannot contribute in the slightest degree to the limitation or prevention of the plague generally. On the contrary, as animals retain during convalescence the power of imparting disease, medical treatment, as a mere sanitary measure, rather tends to spread contagious disease It is, therefore, either not directed, or positively prohibited, as in Prussia. This truth cannot be too strongly stated, namely, that *medical treatment rather favours than hinders the spread of cattle plague, and that its employment must be accompanied with the strictest sanitary precautions.*

Medical treatment. Must be associated with other sanitary measures.

Inoculation is also mentioned in the Austrian despatches as a means of getting quickly through an outbreak of disease within a certain area; but as this method multiplies and increases contagium, precautions against the spread of disease beyond the limits of the area must be redoubled.

Inoculation. Must be associated with sanitary precautions.

When plague spreads extensively over a country, alarm is wont to spread along with it. People are willing to undergo any sacrifice or

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Importance of early adoption of measures.

endure any restriction to get rid of it. Special agencies are then largely entertained, and expensive measures or establishments initiated or employed. Yet, if the simplest precautions or the most trifling sacrifice were adopted or made on the very earliest appearance of an infectious disease, these measures and agencies would be unnecessary. These diseases never attack a whole herd or stable at once. First one falls sick, then several, then the whole flock. If the first one or first several were carefully segregated, and the sound remainder driven off elsewhere till time and disinfection had done their purifying office, it is hardly possible to conceive that disease could spread over a whole district or province; but in the total absence of all precautions, the wonder is that its prevalence is not even greater than it actually is. Meteorological changes and natural barriers are the principal means as yet available in Bengal to stay these plagues.

Measures adopted when plague is enzootic.

IV.—MEASURES ADOPTED IN COUNTRIES WHEN THE PLAGUE IS ENZOOTIC.

RUSSIA.

In Russia, where cattle plague may be said to be an indigenous disease, the measures adopted are, in short, as follows :—

Information. Examination. Census. Separation. Special hospitals. Place of sale. Disinfection. Separate attendants. Smearing with tar. Burial. Products. Dirt, litter, etc. Dogs, cats, etc. By-roads. Food. Setons. Medical treatment. SIBERIAN plague. Meat, etc.

1. Early information through police: penalty for neglect.
2. Examination by civil authority, assisted by veterinary surgeon, and report of nature and cause of disease and measures used to arrest it.
3. Census of cattle.
4. Separation of sick and healthy.
5. Special hospitals for sick.
6. Special place and precautions for sale of cattle.
7. Disinfection of harness, stalls, etc.
8. Separate attendants for sick and healthy.
9. Smearing cattle with tar to prevent conveyance of contagium by flies.
10. Burial of dead and cutting up of their hides.
11. Prohibition of trade in products (meat, hides, milk, tallow, etc.).
12. Burning of dirt, litter, dung, etc.
13. Confining dogs, cats, and fowls.
14. Appointing special by-roads for the use of cattle *en route*.
15. Attention to the food of cattle; hay damped with warm water, to which salt is added.
16. Placing setons in the dewlap.
17. Medical treatment.
18. Precautions against possible infection of attendants. It is stated that human beings may, in various ways, become infected by the Siberian plague.
19. Prohibition of using the meat, milk, etc., of diseased animals.

BESSARABIA.

The following letter, which, from its interest, I transcribe in full, details the measures adopted in Bessarabia, where the disease is permanently prevalent.

CONSUL-GENERAL MURRAY *to the* EARL OF CLARENDON,—*Odessa, dated 8th January 1866.*

Source of information.

The following important information respecting the cattle plague has been kindly supplied to me, in answer to a series of questions I addressed to Prince Manoakbeg and the principal landowners and cattle breeders of Bessarabia. * * * *

Plague permanent. Cause and cure unknown. Disease contagious. Treatment futile.

1. The Bessarabian cattle owners and breeders state that the plague during the last few years has been permanent in New Russia. It exists sometimes in one district, sometimes in another, of that vast country. Up to the present time nothing is known with certainty of the true cause of the disease or of the proper means of treatment for its cure. On one point only there exists no doubt,—it is certainly contagious.

2. No remedies which have been yet tried, neither fumigation, friction, bleeding, nor medicine, have met with enough success to warrant their recommendation. From time to time a few beasts recover, and each person attributes their cure to the remedy he has employed; but general experience has not confirmed such assertions in any case.

Vaccination.

3. One opinion only appears to merit serious attention, and is now under anxious consideration. That opinion is in favour of vaccination, which the Imperial Government has undertaken to introduce throughout the infected districts by competent veterinary surgeons employed for that purpose. Time can only decide whether vaccination will afford a sure protection from the disease, but at present it seems to promise more satisfactory (*sic*) than anything else which has been tried.

Communication prohibited.

4. Effective means may be taken to restrain the plague from spreading. For this purpose it is advisable, as soon as it is found to exist in any district, that all communication with other places should be strictly prohibited.

Burial of carcasses with hides on.

5. Dead animals should be buried as soon as possible, and in no case should it be allowed to skin them previously for their hides. They should be buried in the state they die.

Separate drinking troughs. Separation of sick and healthy. Removal of healthy. Theory of origin.

6. Great care should be taken not to suffer diseased beasts to drink out of the same troughs as healthy ones.

7. Healthy cattle should be separated at once from the diseased; and immediately any beast falls sick among them, the healthy cattle should be taken away and transferred to other pasturages. *By these means large herds have been entirely saved.*

8. These facts are indisputable; but there is still to be mentioned a probable theory as to the origin of the malady.

[This theory attributes the origin of the disease to " the long journeys during the great heat of summer across arid steppes, where no pasture nor wholesome water can be found."—C. P. C.]

9. This seems to be really the sole cause of this terrible diease, and the wagons returning to their several houses spread it throughout the country. * * * * *

Summary of system.

The most important features of these rules are—

1st.—That slaughter is not recommended, nor adopted.

2nd.—That separation of sound cattle and isolation of sick are found to be the best measures.

3rd.—That medical treatment is adopted.

4th.—That inoculation is hinted at.

5th.—That much stress is laid on disinfection.

6th.—That the food and water of cattle are made subjects of care and attention.

C.—SPECIAL MEASURES.

Instruction of population.

I.—Instruction of population.—If the people of a country at large are informed of the nature of the disease and impressed with the reasons on which restrictions, which may be irksome, are founded, a most important aid is furnished in the adoption of sanitary measures. An ignorant, resisting people will abort the best devised and most carefully applied

means, and the less the aid which may be expected from the owners of cattle, the more elaborate and powerful must be the agency to apply sanitary measures, and the more stringent the penalties for this breach. The importance of disseminating information has been already recognised in Bengal.

Indemnification. Circumstances in which made.

II.—Indemnification.—In countries where cattle are slaughtered by order of the civil or other legal authorities, the State pays a fair sum of money to indemnify particular cattle owners for the loss of cattle or property destroyed. As this contingency is not likely to occur in India, I need not enter into particulars as to the mode of estimating the amount of loss incurred. State assistance to ryots in times of severe plague, to enable them to purchase new cattle, is a separate question, not entering into a scheme of sanitary interference. Loans for this purpose are obtained from *zamindars* and *mahájans* at great rates of interest. A system of loaning on reasonable rates in such circumstances would be a boon to cultivators; but other considerations foreign to the scope of this paper enter into this question.

State assistance for purchase of cattle. Loans.

Disinfection; object.

III.—Disinfection.—This process endeavours to destroy artificially the contagium or contagious principle of disease. This is its primary object. A secondary purpose of disinfection is to destroy organic decomposing matters and products of decomposition, which are found by experience to favour the development, or increase the virulence of the contagium. It is an imitation of the natural process by which, through ordinary agencies, certain deleterious organic matters are reduced to a harmless inorganic condition. Several of the measures already discussed are in reality processes of disinfection; slaughter, burial, and burning are examples.

Agencies—heat, chemical agents.

The two principal agencies of disinfection are heat and chemical agents, and heat in the form of fire or boiling water is probably the best disinfectant, and may be used under the following circumstances:—

Valueless articles to be burnt.

(*a*) All valueless articles, or articles difficult of disinfection by other means, should be burnt. Contaminated straw, litter, hay, mats, ropes, bamboos, etc., should unceremoniously be disposed of in this manner; and in this country infected stalls and stables made of matting and bamboo (*kacha*) should be also burnt. They are of little value, and can easily be replaced, while their disinfection otherwise is difficult.

Clothing boiled.

(*b*) Clothing which may be of some value, and has been worn by attendants on sick cattle or others coming in contact with them, may be disinfected by boiling in water. If of little value, it should be burnt.

Chemical agents. English observers.

Chemical Agents.—The subject of disinfection by chemical agency was carefully and scientifically investigated by Dr. Angus Smith and Mr. Crookes for the English Cattle Plague Commission. The latter studied also, experimentally, its application to cattle plague. The report of Mr. Crookes is most interesting and important. After passing in review the various agents available for disinfection, he remarks, that "the choice is therefore limited to the oxidizing disinfectants—*chlorine* and *ozone*, and to the antiseptics—sulphurous and the tar acids"—carbolic and cresylic). The experiments and experience of Mr. Crookes led him to pronounce strongly in favour of the latter class of agents as the most efficient means of destroying the contagium. He details several experiments on farms, from which it appears clear that a free use of sulphurous and carbolic acid does exercise a most potent influence in destroying or rendering inert contagious material.

Best agents.

Sulphurous and carbolic acid.

the spread of cattle plague, etc. (*K. McLeod.*) | **OXEN.**

Directions.

The directions issued by the Cattle Plague Commission, founded on these observations, are, in short, as follows :—

1.—*CLEANSING STABLES, SHEDS, MARKETS, SLAUGHTER-HOUSES, etc.*

Wood-work.

Wash wood-work with boiling water containing a wine-glassful of carbolic acid to a gallon.

Walls, etc.

Lime-wash walls, etc. Use freshly burnt lime, and add one pint carbolic acid to each pailful of wash.

Floors.

Cleanse floors with hot water, and sprinkle with undiluted carbolic acid.

Fumigation.

Close the house and burn sulphur inside for two hours, men and cattle to be removed meanwhile. One pound sufficient for ten or twelve stall sheds.

These measures to be used after every evacuation, or periodically.

2.—*CLEANSING WAGONS, TRUCKS, etc.*

Wagons, etc.

Scrape boards and burn scrapings; wash with boiling water and soda one pound to a pailful, then with chloride of lime or carbolic acid, as in 1.

3.—*DISPOSAL OF MANURE OR LITTER.*

Manure, litter, etc.

Burying or burning best, having previously watered with carbolic solution. It may be ploughed in, or covered with earth for agricultural use. Implements, etc., cleaned and washed with solution. Add one pint of carbolic acid to every 100 gallons of liquid manure.

4.—*DISPOSAL OF CARCASSES.*

Carcasses.

Bury six feet deep, covering with quicklime and carbolic acid.

5.—*DISPOSAL OF BLOOD, OFFAL, HIDES, etc.*

Blood, offal, hides.

Bury blood and offal, having mixed with carbolic acid; wash hides with carbolic solution, or soak in solution of chloride of lime, after covering with salt for twelve hours.

6.—*PRECAUTIONS TO BE TAKEN BY BUTCHERS, etc.*

Butchers.

Should not approach healthy beasts in infected clothes; should wash and dip boots in carbolic solution; sprinkle their clothes with the same.

Clothes and baskets may be steamed or placed in boiling water.

7.—*FURTHER DISINFECTING MEASURES.*

Washing cattle.

Wash cattle with mixture of one pound soft soap, one wine-glassful carbolic acid, and one gallon of warm water.

Sprinkling floors.

Sprinkle floors, walls, etc., with undiluted carbolic acid.

Smell of carbolic acid.

The smell of carbolic acid should be sensible over farm-yards, stables, etc.

Cattle may lick acid.

Cattle may lick carbolic acid without danger.

Clothing, etc., fumigated.

Clothing, baskets, tools, utensils, etc., may be fumigated with sulphur.

Cleanliness.

The utmost cleanliness should be always preserved.

Destruction of valueless articles.

In this country destruction by fire will be the most appropriate and effectual disinfecting agency, as the infected articles will, in most cases, be of little value and easily replaced. Next to it will come sulphur fumigation, sulphur being obtainable in every bazaar. Carbolic acid, which is considered the best antiseptic, is expensive, and not easily obtained; but tar may be used for many disinfecting purposes, as it is in Russia.

Prussia.

In Prussia fumigation by chlorine is prescribed, but its evolution is more difficult and dangerous, and its action not so effectual. It belongs to the class of oxidising agents which are found to attack the contagium of the disease less promptly and efficiently than the antiseptics.

OXEN.	Measures adopted to oppose

FRANCE and BELGIUM.

In France and Belgium carbolic acid is employed similarly as in England, and the stamping out of two outbreaks during the prevalence of cattle plague in England was thought to be materially assisted by the liberal use of carbolic acid.

Having pointed out the best disinfectants known, it is unnecessary to enumerate others recommended by other countries.

Inoculation and vaccination.

IV.—Inoculation and vaccination.—The aim of inoculation is, by artificially inducing an attack of disease, to render the subject of experiment not liable to another of the same malady. The well-known peculiarity of eruptive fevers rarely to attack a man or animal twice is turned to account, and the less fatal form of a disease communicated artificially in this manner is the main reason of the measure. English experience proved both vaccination and inoculation a complete failure. Vaccination, which was tried on a very large scale, proved utterly useless as a protective, and the mortality from inoculation was as great as from the disease naturally communicated. On the Continent, especially in Russia, experience has been more favourable. It has been found possible, either by selecting a mild form of disease to inoculate from, or by mitigating the severity of the virus by successive transmissions through animals, to induce a mild disease whose mortality is only 6 to 10 per cent. This result is not, however, uniform, and too mild a manifestation is found not to be protective: that is to say, animals which sickened only very slightly from inoculation, contracted the disease when exposed to natural infection.

Reasons. English experience. RUSSIA. Varying results.

Experiments required.

Before men entertaining the expediency of inocculation in this country it is necessary to ascertain by experiment

(*a*) whether a mitigated form of Rinderpest can be obtained;
(*b*) whether the one disease, either naturally contracted or communicated by inoculation, is protective against the other;
(*c*) whether the induced mitigated form of disease is efficiently protective against either or both forms of disease (*gootee* and *puschima*);
(*d*) whether different localities, seasons, periods, or epizootics modify the results.

The result of these being favourable, other questions arise.

Presuming that such a mitigated form of disease may be obtained (of which I am far from sanguine) with a mortality of, say, 5 per cent., very serious questions follow:—

Universal compulsory inoculation.

1. Are all the cattle of Bengal to be compulsorily inoculated? Is a vast establishment to be spread over the province, 5 per cent. of all cattle to be voluntarily sacrificed, a serious waste of the time of the agricultural class, and probable interruption of their labours, to be incurred in consequence of the sickening and temporary disablement of their cattle and the habits and prejudices of a very large section of the community rudely interfered with, and all this for the sake of the few hundred or even thousand cattle that are yearly carried off by cattle plague? To this question there can only be one answer,—an emphatic negative.

Indiscriminate inoculation.

2. Are the people to be permitted, if they wish it, to practise inoculation, when, where, or how they like? This would amount to nothing short of voluntarily spreading the disease abroad.

Inoculation with precautions.

3. Are the people to be permitted, under proper inspection and precautions, to protect their cattle? Unless the inspection is strict, the precautions sufficient and thoroughly carried out, the effect of such a system would be the same as the last.

Establishments for inoculation.

4. Are properly trained establishments to be placed in every district in which inoculation may be performed under proper rules and restrictions, the cattle being voluntarily brought by owners for the purpose? This system obtains in Russia. Unless the people were convinced of the expediency of the system, it is highly improbable that they would volun-

tarily adopt or fall into such a system; and the agency required for the purpose presents an insuperable obstacle as yet.

5. When plague prevails in a certain area, are all the cattle of this area to be inoculated in order to get rapidly over the plague? This is the Austrian system; but unless an efficient cordon were maintained around the area, the measure would only tend to spread disease. Inoculation in "infected areas."

It is very evident that the time has not come for the introduction of any system of inoculation into this country, and the slender prospects of much benefit being eventually obtained by its introduction would even contra-indicate the performance of a series of experiments to determine its possibility, which must be on a large scale and involve great expense. Introduction of system not advisable.

V.—Trade in hides, etc.—If the hides, horns, and offal of animals dying of cattle plague are buried along with the carcass, there can be no risk of spreading the disease by their means. In order, however, to prevent any risk which might ensue from carelessness or culpable neglect, it would be advisable to prohibit all export of such products, or dealing in them, from or in infected districts, unless they were thoroughly disinfected in salt, chloride of lime, carbolic acid, and dried in the sun. The systematic poisoning of cattle for the purpose of obtaining their hides, which has recently been brought under notice, is another question of importance, demanding action of another sort, which I need not discuss. It is plain that such poisoning can hardly occur *epizootically*, but must be a more or less constant quantity in districts where such nefarious practices prevail. Trade in hides. Burial of products. Prohibition of exportation from infected area. Disinfection. Cattle poisoning.

VI.—Penalties.—In all European countries penalties of considerable severity attach to neglect or infringement of the regulations framed for the purpose of checking the spread of cattle diseases. The penalty is always more severe when it can be clearly proved that the spread of disease and loss to the community have resulted from the neglect. The propriety of attaching a penalty to the neglect of regulations of this sort depends upon (*a*) the clearness of the premises and certainly of the facts on which the rules are founded; (*b*) on the character of the people; and (*c*) on the kind and amount of loss to the community which such neglect may entail. Penalties. Circumstances on which the propriety of imposing a penalty depends.

D.—Conclusion.—Of the various sanitary measures passed under review in the foregoing, those which in the present circumstances seem most suitable to this country are as follows:— Conclusion. Summary of measures applicable to this country.

1. Gathering, systematising, and publishing information.
2. Inspection when disease has been reported.
3. Duty of giving notice inculcated.
4. Skilled examination of disease and narratives by competent persons of its nature and behaviour.
5. Proclamation of infected areas.
6. Isolation of sick and separation of healthy.
7. Stopping markets and cattle movement in infected areas.
8. Burial of carcasses after scoring hides.
9. Disinfection, including the destruction of dung, fodder, etc.,—anything by which disease may be spread.
10. Medical treatment, combined with sanitary precautions.

When information has accumulated and experience has been enlarged, the course of preventive or restrictive action will become more definite and clear. Meantime, enough of experience has been gained to indicate what owners of cattle must do and avoid; and if that is clearly set forth, and civil authority brought to bear strongly in support of directions and restrictions, good must accrue in the prevention of disease and saving of stock.

O. 590-94.

G. I. C. P. O.—No. 166 R. & A.—3-10-96—2,100.—W. B. G.

(Agricultural Series, No. 18.)

THE

AGRICULTURAL LEDGER

1896—No. 21.

EMBANKMENTS.

(GRASS SOWING.)

[*Dictionary of Economic Products, Vol. III.*, E. 198 a.]

GRASS SOWING OPERATIONS IN THE UMBALLA DISTRICT.

Report on MR. C. E. GLADSTONE'S *Planting and Grass Sowing Operations in the Umballa District, by* J. F. DUTHIE, ESQ., *Director, Botanical Department, Northern India, preceded by correspondence relating thereto.*

From the Senior Secretary to the Financial Commissioner, Panjab, to the Revenue Secretary to the Government of the Panjab,—No. 423, dated Lahore, the 26th of June 1893.

With reference to your endorsement No. 79, dated 13th May 1893, I am directed to submit a letter from the Director of Land Records and Agriculture, Panjab, No. 1055, dated 14th June 1893, with its enclosures, regarding Mr Gladstone's planting and grass growing operations in the Umballa District, and to say that the Financial Commissioner concurs in Mr. Francis' remarks.

From E. B. FRANCIS, Esq., *Director of Land Records and Agriculture, Panjab, to the Senior Secretary to the Financial Commissioner, Panjab,—No. 1055, dated 14th June 1893.*

As directed by Government I have the honour to forward copy of letter No. 619 of 23rd ultimo, from the Conservator of Forests, together with Mr. Duthie's original report on grass cultivation and other operations in the Umballa District.

E. 198 a.

2. There are no doubt many places under the Siwaliks where injury by torrents might be prevented or restrained by judicious planting of grass, construction of spurs, etc. These works are usually the business of a single village or group of two or three villages. If the villagers can agree to repay the cost of the works, they might generally, I think, be suitable objects for expenditure from the District Fund.

3. The general question of attacking the Siwalik torrents at their source is, I believe, awaiting the passing of legislation. The necessary works will, probably, be very expensive, and there is consequently no prospect of anything effectual being done for some time.

4. Mr. Duthie's conclusion that grass lands cannot generally be improved without irrigation, even in a district with so heavy a rainfall as Umballa, is an important addition to the discussion regarding fuel and fodder reserves. Very little ground susceptible of irrigation is now allowed to lie waste.

From the Conservator of Forests, Panjab, to the Director of Land Records and Agriculture, Panjab,—No. 619, dated 23rd May 1893.

* Copy of the Revenue Secretary to Government of Panjab's No. 77, dated 13th May 1893.
Copy of Under Secretary to Government of India's No. 966, dated 28th April 1893.

I have the honour to forward, for submission to Government, the correspondence marginally noted and to offer the following remarks:—

2. The grass operations referred to are of two kinds:—

(1) the planting of Saccharum ciliare (*munj*) to fix sandy soils;

(2) the sowing of good fodder grasses to improve pastures.

3. With regard to the former I may mention that in April last, on my way from Chachrauli to Kalesar, I noticed several places where sandy soil on the roadside had been planted with *munj*, those clumps which had been planted over a year were flourishing and the top growth had been cut, those plants which had been more recently planted were mostly alive, but had not made any growth. I can thus testify to the success of this experiment.

4. Mr. Duthie incidentally notices a case where the erection of *bands* had saved the town of Sadhaura from destruction by a

torrent and the silt thrown up by the flood water had been naturally covered with "Kans" grass.

On the journey referred to above, I noticed a case where the want of such *bands* had resulted in the destruction of a *pakka* well. On the right hand of a wide torrent bed was a well on the outskirts of a village, the land had been cut away between the well and the village, and the brick masonry of the well was left standing up like a tower from the sandy bed of the torrent: the next flood will probably overthrow the tower and possibly carry away a piece of the village.

5. There must be many similar cases in these submontane districts, and my object in mentioning the case which came under my personal observation is to emphasize my opinion that this work of protecting land from erosion and of fixing sandy soils is one which urgently needs a systematic and continuous policy.

Much may be accomplished by a Deputy Commissioner who happens to remain for a long time in one district and takes an interest in such matters, but where changes of officers are so frequent and the area affected so vast, individual efforts can be of but little avail.

6. If a report was framed showing the most important of such works needed in each district, and a scheme drawn up, laying down the work to be done during a period of, say, five years, the District and Local Boards and village headmen might be made responsible that each year's operations be duly carried out and each new Deputy Commissioner coming to the district would know what work was to be done.

7. With regard to the second matter treated of, *viz*, the improvement of pastures, I quite agree with the Director, Botanical Department, that without irrigation the attempt to introduce new grasses by sowing is not to be lightly undertaken.

The first thing to do is to exclude cattle, then if possible to top dress; the first measure alone and certainly the second combined will suffice gradually to kill out the coarser and to encourage the better kinds of grass.

8. The co-operation of the officers of this Department as suggested in Mr. Duthie's paragraph 3 will always be willingly accorded. *Conf. p. 1.*

UMBALLA DISTRICT.

Report on* Mr. C. E. Gladstone's *Planting and Grass Sowing Operations in the Umballa District, by* J. F. Duthie, Esq., *Director, Botanical Department, Northern India.

I spent three days in November last with Mr Gladstone, Deputy Commissioner of Umballa, visiting various spots in his district where experimental plantings and sowings had been made.

Sadhaura.

We left Umballa by train on the morning of the 4th for Barara, the second station on the line towards Saharanpur, and from there we rode to Sadhaura, a small town in the Naraingarh tahsil.

Uses of *munj* grass.

There is a good *katcha* grass-covered road all the way, and on either side the *munj* grass (Saccharum ciliare) has been extensively planted in rows. The local name of this grass is *bind-pula*. It is planted here mainly for the protection of the road which is liable to be flooded during the rainy season. For this purpose it is very suitable, as it thrives well in a sandy soil if care is taken to put in the young plants at the proper season. It is also a very profitable plant to grow for the sake of its stems and leaf sheaths. The well-known *munj* fibre is prepared from the latter, whilst the flowering stems (*bind*) are used for a variety of purposes. The lower portion (*Kána*) is a good material for baskets, chairs, etc., and the upper part called *til* is employed in the manufacture of *sirki*, the thin thatch used for covering carts in wet weather.

Of *bana*.

Bana (Vitex trifolia), a shrub belonging to the VERBENA family, is also largely used here as a soil-binder.

Results of planting *munj* or *bind-pula* grass.

We turned off the road towards the west near the village of Murana in order to visit some very sandy ground near the river, where attempts are being made more or less successfully to reclaim the land, and to arrest the encroachment of sand by planting the *bind-pula* grass on the sand hills. These hills are composed of absolutely pure blown sand, but the *bind-pula* grass, if planted in tufts during the rainy season, strikes root, and very soon effectually retards any considerable advance of sand particles. Encouragement is thus given to the growth of other plants which are less able to endure submergence in sand, and in this way the ground becomes reclaimed. Examples of all stages of reclamation may be seen in this neighbourhood.*

* The planting of *munj* grass for the purpose of binding loose sand is well known to native zamindars; and this same grass has been used successfully at Jaipur, where it is known by the name of *panni*.

GRASS SOWING OPERATIONS.

The *Káns* grass (Saccharum spontaneum) plays an important part in the process of reclamation. This grass produces an enormous quantity of seed after the rainy season is over. The seeds (or more correctly fruits) are covered with soft hairs which enable them to be carried by wind to very considerable distances. They readily germinate on river banks and low-lying land where the soil is at all moist. *Káns* possesses also an extraordinary amount of vitality in its stems, which are capable of producing individual plants at every node or joint. Owing to the sudden and heavy floods brought down by the rivers of this submountain tract, and the frequent shifting of their beds, it often happens that large stretches of *Káns* pastures are uprooted, and the plants are carried down by the stream and deposited here and there along their banks where they again strike root; or, if there be sufficient wind, they may be carried for some distance on to the strips of sandy ground on either side of the river, and then become established. I noticed several instances of wind-borne *Káns* plants, and even single stems, anchored by root growth from the nodes.

Káns grass an important reclaiming agent.

Manner of taking root.

The town of Sadhaura, which is a very ancient one, is situated on elevated ground on the left bank of the river. It has been dangerously encroached upon of late years during heavy floods. To prevent further damage Mr. Gladstone had some *bands* erected at suitable spots higher up the river, by which means the main portion of the stream has been deflected to the opposite bank, and at the same time an enormous quantity of silt has been deposited where erosion had previously taken place. This layer of silt is now covered with a thick crop of self-sown *Káns*; and the town is now safe.

Sadhaura.

Erection of *bands*.

Successful result.

Some of the grass seed supplied from Saharanpur was sown on the banks of the river a little below the town, and Mr. Gladstone showed me some seedlings of takrja (Panicum sanguinale) which had evidently resulted from these sowings.

On the following day we rode to Garhi *viá* Naraingarh. At a place called Ismailpur, a short distance from Sadhaura, I was shown an interesting example of land completely reclaimed by planting *bind-pula*, and by keeping out cattle. The ground was originally bare sand and shifting sand hills, not only useless to the owner, but a source of injury to the cultivated ground in the vicinity. The cost of reclaiming such land must be amply repaid by results. The

Ismailpur.

Results of planting *bind-pula* and excluding cattle.

UMBALLA DISTRICT.

process is simple enough, and only a little energy and perseverance are required to carry it out successfully.

Sadikpur.

We then went on to a place called Sádikpur to inspect a piece of ground where the bulk of the Saharanpur grass seed had been sown. The land here is undulating, and cut up by numerous ravines. Cattle had been excluded from this plot, and on a portion of it the grass seed had been scattered. I could see no difference, however, between the condition of the grasses on this, and on the unsown portion. Owing to protection from cattle vegetation was, as one would expect, much more luxuriant than that outside the enclosure.

Without irrigation sowing of grass seed not recommended.

Exclusion of cattle.

Manuring.

I do not believe that any useful results are to be obtained by sowing grass seed indiscriminately on waste land in the absence of artificial irrigation. Where such irrigation is not available one must rely solely on protection from cattle, and this alone will generally lead to excellent results if the natural grasses within the protected area are worth protecting; and any available manure which can be given as a top-dressing would not fail to improve the quality of some of the grasses.

During the afternoon we visited another piece of ground where the Saharanpur seed had been sown. The land in this place is flat and close to the river bed. The vegetation here also was noticed to be in a flourishing condition in consequence of the absence of cattle grazing, but it could not be distinctly perceived that any access of grass growth could be attributed to the sowings.

On the next day we reached Mubarikpur, which is close to the Ghagar station of the Delhi-Kalka line, and from there I returned to Saharanpur by rail.

Results of experiments considered.

The conclusions in my mind to be drawn in consideration of the results of these experiments are:—

Conclusions.

Grass sowing.

Over-grazing.

(1) That grass sowing on unirrigated waste land is best left to nature, as it is impossible to imitate by any artificial means the exact conditions required for successful natural reproduction. Much, however, can be done to improve natural pastures, and the most important operation in this direction is protection against over-grazing.

GRASS SOWING OPERATIONS.

(2) That the results of experiments undertaken in this district to counteract the destructive power of the many troublesome torrents which intersect this part of the country shows to what extent water may be utilised as a constructive agent. For instance, the erection of the *bands* near Sadhaura not only saved the town from destruction but induced the river to undertake by silt deposit a piece of earthwork which would have cost thousands of rupees to construct by manual labour.

Formation of bands.

(3) That the necessity for any engineering works at the lower parts of these rivers would be considerably lessened if proper measures could be taken to control and regulate the flood water nearer their sources. The planting of trees and shrubs would certainly help to remedy the evil; and for the proper carrying out of this operation we need the help of the Forest Officer.

Control of flood water assisted by planting trees and shrubs.

G. I. C. P. O.—No. 402 R. & A. D.—5-11-96.—2,100.—J. E. F.

(*Vegetable Product Series, No. 25.*)

(*Dyes and Tans.*)

THE
AGRICULTURAL LEDGER.

1896—No. 22.

AL DYE—MORINDA.

[*Dictionary of Economic Products, Vol. V., Pt. I.,* M. 651-716.]

AL DYEING AND CLOTH PRINTING IN THE CENTRAL PROVINCES.

Note furnished by the Commissioner of Settlements and Agriculture, Central Provinces.

The following brief note upon the *Al* dye and cloth printing industries as carried on in the CENTRAL PROVINCES has been furnished by the Commissioner of Settlements and Agriculture. The particulars thus afforded are here given in continuation of *The Agricultural Ledger, 1895, No. 9, Al Dye—Morinda.* It may be added that in his forwarding letter No. 259—163, dated the 22nd January 1896, the Commissioner speaks of the difficulty there exists in obtaining trustworthy information, and states that the *al* industry is almost extinct.

I. CULTIVATION.

The enquiries made indicate that not long ago a fair amount of *al* cultivation took place in certain districts of the Central Provinces, such as Jabalpur, Saugor, Damoh, Narsinghpur and Nagpur. In the Narsinghpur District the villages of Patoha, Kalianpur, Sani Khera, Kandeli, Simaria, Maniwari, and in Jabalpur Kainwri and Majholi Indrana, were a few years ago noted for their large cultivation of *al*, but the introduction of aniline dyes, which are cheaper though not so durable as *al* dye, has almost entirely driven the latter out of the market, and the cultivation of the *al* plant has now shrunk to insignificant proportions and is confined to very limited areas situated in a few localities.

In the Narsinghpur District, for instance, only 11 acres are now under the crop.

In the Jabalpur District there is still a fair dyeing industry, but *al* cultivation appears to have altogether ceased. In Damoh there are reported to be still about 100 acres of land under *al*.

In Nagpur, some cultivators have an acre or two under *al*, but the industry is quite unimportant here as elsewhere.

In the Seoni District *al* was formerly grown in a village called Sanpapar, though on a limited scale, but the cultivation has not been carried on in recent years.

2. The *al* seed is of a dark black colour and somewhat resembles that of the hemp plant. It sells at about a *ser* and a half for a rupee.

M. 651-716.

CENTRAL PROVINCES

Mode of cultivation.

At the commencement of the monsoon the seed is mixed with cowdung and allowed to remain in that condition for two or three weeks until the outer cover has decayed. It is then washed and considered fit for sowing.

3. After the first rains in June or July the ground is ploughed several times at intervals of a few days. The *al* is then sown broadcast and a harrow used to cover the seed with earth. Germination takes place in two or three weeks.

4. The plant is grown in light (*patrooa*) soil or in *kali* or *morand* wheat land. Like *juari*, mixed with which it is sometimes sown, *al* thrives best on sloping ground, from which the rain water can easily drain away.

No irrigation or manuring is practised. Both are said to be injurious to the plant.

Fruits in five to six months.

5. The young crop requires very careful watching, as cattle browse readily on it. The field is weeded in September and again in November.

After the second weeding the first crop of fruit is picked and kept for seed. Weeding usually takes place twice more during the first year. A second crop of fruit is gathered in the second November after sowing. The roots are dug up and gathered in the third year of the plant's growth. The plant is by that time about 1½ feet high.

Roots collected in third year. Yield.

6. The value of the crop would appear to be about R50 and the expenses of cultivation about R40 an acre. The gross produce amounts to about 700lb of *al* root an acre. The thinner portions of the root are reputed to be more valuable than the thicker parts. These figures are, however, but rough estimates, as the statistics furnished by different officers vary within wide limits. In point of fact there is now so little *al* cultivation that a basis of solid fact is difficult to obtain, and many witnesses have merely indistinct memories of cultivation long ago abandoned.

7. The cultivation of the *al* plant is not confined to any particular caste; Lodhis, Kurmis, Kachis and other of the cultivating castes take part in it.

Treatment of roots.

8. After being dried in the sun, the roots are pounded to a fine powder and mixed with an equal quantity of dried flowers of the *Dhabai* tree (**Woodfordia floribunda**). The mixture is boiled for a day or sometimes two days. The red liquid dye resulting is sold at R1 to R1-8 a *ser*.

The process of extraction of the dye and of dyeing materials is generally performed by a caste called *Chhipas*.

Process of dyeing.

9. The process of dyeing with *al* is the same as that in use with the imported colour powders. The cloth (or yarn) to be dyed is first washed in a stream and then moistened with a solution of powdered Myrabolans. After being dried it is again damped, this time with a solution of alum.

First *Dhabai* flowers and then an equal quantity of the colour—either *al* or the imported dye—are dissolved in a cauldron of boiling water, and the cloth is dipped in the mixture and stirred about in it for 6 or 7 hours until it has completely absorbed the colour. A little oil is sometimes mixed with the *al* in order to make the colour fast. On removal from the cauldron the cloth is repeatedly rinsed in the water of a river and sun-dried on its sandy bed.

10. Thin cloths are generally coloured with imported dyes, but rough cloths, quilts, floor cloths, etc., are still not infrequently dyed with *al*. Small quantities of *al* are imported to the Jabalpur and Balaghat Districts and various other seats of the dyeing industry from the Berars and some of the few parts of the Central Provinces where *al* growing is still practised on a small and fluctuating scale.

Imported dyes.

The lower price of the "Congo Red" and other brands of imported dye, coupled with the regularity of their supply, and the shorter time required in the process of dyeing with them, has enabled the foreign

CENTRAL PROVINCES.

colour to supplant the local product. Though the *al* dye is much faster than the European stuff, a cloth dyed in it costs about twice as much as one coloured with aniline dyes, and it is to be feared that the *al* industry is in a way to shortly give place entirely to its cheaper substitute.

II. CLOTH PRINTING.

Calico Printing.

The cloth printing industry was formerly of some importance in the Central Provinces, but as with the manufacture of *al* dye so in this, too, the importation of a cheaper line of goods has inflicted a fatal blow on the Indian industry. A generation ago a thriving business was carried on at Marwara and Kymori in the Jabalpur District, where now only a few households of Chhipas remain.

The process of cloth printing in those parts is as follows:—A *ser* of gum is dissolved in a little water and mixed together with one-eighth of a *ser* of powdered alum, a *tola* of turmeric and a *tola* of *gheru* powder in a couple of *sers* of water: when these ingredients have dissolved, the mixture is ready.

The cloth to be printed is first cleaned by careful washing in cold water, then dipped in a solution of an eighth of a *ser* of powdered myrabolans in four *sers* of water. The cloth is next dried and then dipped in a solution of one-tenth of a *ser* of alum in the same quantity of water. After being again dried in the sun, the cloth is spread out on a stand or other flat surface, and impressed with a stamp dipped in the printing mixture above described. The cloth is then dried, next washed in running water, and forthwith immersed in dye of the colour desired.

After some hours the coloured cloth is removed, and while still wet is steeped in a mixture of one-eighth of a *ser* of sheep-dung dissolved in four *sers* of water. Next day the cloth is frequently washed in running water and sun-dried in the intervals between the washings. The colour and print then become fast. To give a gloss to the cloth a further process is required. A *ser* of ground rice is boiled in four or five *sers* of water for a short time. A handful of the sticky mixture resulting is dissolved in a bowl of water and the cloth soaked in the same. When removed and dried the cloth acquires a glossy appearance.

G. I. C. P. O.—No. 167 R. & A.—25-7-96.—2,100.

THE

AGRICULTURAL LEDGER.

1896—No. 24.

ANDROPOGON SORGHUM, *Brot.*

(THE JUAR.)

[*Dictionary of Economic Products, Vol. I.,* A. 1120 a.]

POISONING OF CATTLE BY THE JUAR PLANT

through the large deposits of Nitrate of Potash that under certain conditions are thrown down in the stems. *By* VETERINARY-CAPTAIN PEASE, A.V.D., F.Z.S.

It has for a long time been known to the native agriculturalist, and to others who take an interest in cattle, that the usually wholesome and useful fodder plant *juar* (**Andropogon Sorghum***) becomes, in certain circumstances, poisonous, and causes the death of animals which eat it in any quantities.

Conditions under which *Juar* is believed to become poisonous.

The conditions in which the plant becomes harmful are, when owing to failure of the rains, the plant becomes stunted and dried up. The popular idea amongst the natives of this country is that in these conditions the plant becomes attacked by a small insect to which they give the name of "*bhaunri*" and it is to the animal eating this insect with the *juar* that they attribute death.

Name and history of Disease.

Vernacular Name.—In the Panjab where the disease is very common this form of death is known to the people as "*patha largaya*" or "*patha lag gaya.*"

Previous Notices.—The fact of animals being poisoned by this plant has given rise, at various times, to some enquiries being made as to the cause, and various theories have been advanced to account for it. Some of these will be found at length in the *Dictionary of Economic Products* under the heading "**Sorghum**" at page 303, Vol., VI. Pt. III.

* In Vol. VII, p 183 Fl. Br. Ind. Sir J. D. Hooker refers this plant to the genus Andropogon under the above name which should now be given for the *juar* instead of the familiar Sorghum vulgare.—Ed.

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The following occurs :—"It is otherwise with the insect pests. Some of them are fully understood, others are so obscure that much difference of opinion prevails as to whether the poisonous property (spoken of as possessed at times by the stems, when used as fodder) is due or not to an insect. In the special article on Pests (Vol. VI., Part I., page 147) it is stated that the larvæ of a moth known in the North-West Provinces as "*bhaunri*" (not yet identified) attacks the *juar* stalks in much the same way as the sugar-cane is channelled by the sugar-cane borer. These larvæ, in fact, bear so strong a resemblance to those found in the cane that Mr. Cotes suggests, that they may also set up decompositions sufficient to cause the poisonous properties regarding which so much has been written. It may be added that the prevalent idea amongst the natives is that the poison is the result of an insect, and it is worthy of note that it occurs at the same period, and under similar conditions as in cane, *viz.*, during an exceptionally dry season. The following two passages may be taken as representing the somewhat exhaustive controversy that exists on this subject :—"The most peculiar diseases to which the *juar* is liable is that which makes the stalks poisonous to cattle if eaten by them when semi-parched from want of rain. Of the fact there can be no doubt; in the scarcity of 1877 great numbers of cattle were known to perish from this cause, their bodies becoming inflated after a meal of the young *juar* plants and death ensuing shortly afterwards, apparently in severe pain. A good explanation, however, is not forthcoming. The opinion universally accepted by the natives is that young *juar*, when suffering from deficiency of rain, becomes infected by an insect named "*bhaunri*," to which its poisonous effect on cattle is due. Immediately the rain falls the insect is said to perish, and unless the ears have appeared before the rain failed the crop often recovers itself and yields a good outturn of grain" (*Duthie* and *Fuller*).

Mortality of cattle in 1877.

Alleged cause.

Another view.

A totally different explanation of the great mortality amongst cattle in the year 1877 is given in a paper by Veterinary Surgeon J. Anderson (*Agri. and Hort. Soc. Journal: New Series*). The following extracts will show the opinions arrived at by that writer :—"From my recent experiments and investigation I have come to the conclusion that *juar* is not poisonous. Some stocks here and there

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contain insects, others a fungus, both of which are supposed by many to be the medium of poison. Even if they were poisonous they are not found in sufficient quantity to prove injurious and account for such wholesale mortality. The prevailing idea is that *juar* has become poisonous not only from the want of the usual rains, but also from the effects of the unusually hot winds, or that a poisonous gas is engendered in the stalks by the heat, etc. I look upon *juar* as a destructive substance or thing, and not as a poison. It destroys life by acting mechanically on the system. When it has been eaten it generally produces hoven or distension of the first stomach, which is recognized by the generation of a large quantity of confined air, a product of fermentation arresting the natural functions of rumination and digestion, which causes the animal to swell, even to a state of suffocation." This writer is of opinion that the disease is nothing more nor less than the ordinary tympanitis in an epidemic form.

Conditions under which *Juar* becomes injurious.

Climatic disturbances, such as want of rain, excess of humidity, or damp cloudy weather, and extreme and unnaturally high temperature are said to cause *juar* to become poisonous. It is remarked in the Dictionary that "it will be observed from the remarks already offered as to whether it is due to the presence of an insect, or to some physiological change in the growth of the plant owing to climatic disturbances, the *juar* stems are not always liable to cause injury to cattle. The occurrence of the poisonous property as it has been called, is simultaneous over a large tract of country, appearing and disappearing within certain fixed limits of time. The inference is therefore unavoidable that the stems have been affected or altered in some way.

Juar is mostly grown on high lands as a "*kharif*" crop and is only occasionally irrigated. It is dependent on the rains for its moisture. A delay of the rain or an unusually high temperature, which withers up and stunts the *juar*, is necessary for the production of the change in properties which causes it to become poisonous.

Juar poisoning common in the Panjab.

During my tour last year I found mentioned in all the districts of the Panjab visited that this was a very fatal form of poisoning, the nature of which I could only speculate upon as I was unable to see any cases of it. Owing to the failure of the rains and the prevalence of a high temperature this year, however, I have been able to

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Only imperfectly developed plants believed to be poisonous.

see animals which have succumbed to the disease, as well as those subjects of it. Certain points struck me in connection with them. It appeared that the plant only gave rise to the poisonous symptoms when it had been stunted and withered up to some extent, when it had grown to a certain height, and when the rains had failed. This did away with the "tympanitis theory," for the plant would not be in a condition to undergo fermentation in this condition so much as it would when it contained more moisture. Another point noticed was the rapidity with which the symptoms developed, and led to a fatal termination, death being almost apoplectiform in some cases, and the majority of the animals attacked dying very rapidly, too rapidly for tympanitis. The people also told me that a crop of the plant which had become stunted and poisonous, lost its poisonous properties if heavy rain fell. Taking these points into consideration, and looking to the symptoms shown by the affected animals, I came to the conclusion that the deaths might be ascribed to the action of an irritant poison, giving rise to gastro-enteritis, and causing marked alteration in the blood. What this poison might be, however, was a difficult problem to solve, especially as I was thrown off the scent by suspecting that it was probably a poisonous mould or fungus. On inspection of the *juar* which had been given to the dead animals, I was very much surprised, on breaking open the stalks, to find a very considerable quantity of a white salt deposited in crystals in the pith, more especially at the nodes. The salt to the taste was cooling and saline, very like Nitrate of Potash. On burning a piece of the stalk there was marked crepitation. I collected some of the stalks and subjected them to a chemical examination which revealed the fact that the salt was Nitrate of Potash. The quantity of the salt in the stems was so considerable (25 per cent.) that there was no doubt in my mind that this was the cause of the deaths of the cattle which had been fed upon it.

Heavy rain stated to cause injurious properties to disappear.

Juar used, found to contain Nitrate of Potash.

Sirsa fair. Fatal cases among cattle caused by *Juar*.

At the last Sirsa fair a number of deaths were caused by poisonous *juar*, and Veterinary Assistant Hakikat Rai to whom I had mentioned the fact of animals having been killed by the development of Nitrate of Potash in *juar* stems found that the *juar* was in the same condition as that which I had previously examined. He sent me a small bundle of this for opinion and I took the opportunity of having it

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carefully analysed by an analytical chemist in Bombay who reports as follows :—

Analytical Department, Victoria House, Bombay.

Caused by Nitrate of Potash in the stems.

"I have made a chemical analysis of a sample of "*juar*" (**Andropogon Sorghum**) and find that the stem contains Nitrate of Potash to the extent of 75 grs. per ounce weight of the plant. This proportion refers to the bulk sample given to me by **Veterinary-Captain Pease**, but the salt is very unevenly distributed throughout the plant, being most abundant in the stem at the nodes or junction of the leaves. The plant contains no other salt in appreciable quantity."

The 20th April 1896.

THOS. STEPHEN, F.C.S.,
Analytical Chemist.

Conclusion.

Judging from these observations, I have no doubt whatever that the *juar* plant, at times, in certain circumstances, such as have been mentioned above, becomes distinctly poisonous owing to the amount of Nitrate of Potash which is contained in the stems.

Experiment to test the effects of Nitrate of Potash.

In order to test the poisonous properties of Nitrate of Potash a heifer was given 10 ounces of the drug in a drench. In ten minutes she commenced to urinate and she was dead in 20 minutes with symptoms of gastro-enteritis, tympanitis, nausea and colic, staggering gait, stupefaction polyuria and death. Authorities on the subject state: "Sometimes death from Nitrate of Potash poisoning is apoplectiform, and we may at times observe spasms and rotation of the eyelids. It is generally very rapid, the animal may succumb in a few minutes. Usually it lasts from half an hour but seldom over 12 hours. *The post mortem appearances* are those of hæmorrhagic gastro-enteritis, cherry red or purple colouration of the gastric mucous membrane and that of the small intestine, and superficial ulceration of this membrane. The intestinal contents are reddish brown. The kidneys are ecchymosed and inflamed. The intensity of the effects of this drug is in inverse ratio to the fulness of the stomach.

Result.

Juar poisoning caused by Nitrate of Potash.

There can be no reasonable doubt that in the cases of poisoning from this plant the cause is the presence of large quantities of Nitrate of Potash in the stems. Some of the samples examined contained 25 per cent. of this salt, so that a very small feed of them would introduce sufficient to carry off the animals which ate them. It is therefore necessary to avoid *juar* in this condition, or, if animals are starving and damaged *juar* is available, cutting up the plant and washing it would, by removing the salt, render the plant harmless.

Preventive measures if fodder other than *juar* cannot be had.

A. 11202.

G. I. C. P. O.—No. 183 R. A.—11-8-96—2,100—W. B. G.

(Medical and Chemical Series, No. 5.)

THE AGRICULTURAL LEDGER.

1896—No. 25.

AILANTHUS EXCELSA.

[*Dictionary of Economic Products, Vol. I.*, A. 658.]

BARK OF AILANTHUS EXCELSA.

By DAVID HOOPER ESQ., *Government Quinologist, Madras. Reprinted from the Pharmaceutical Journal, October 26th, 1895.*

Description.

The tree known as **Ailanthus excelsa**, *Roxb.*, attains the height of about eighty feet and forms a very ornamental and imposing feature in the landscape. There are three trees of this genus common in many parts of India. They are all bitter like many other plants of the Natural Order **Simarubaceæ**, and they all have medical properties attributed to them The **A. glandulosa**, *Desf.*, is probably an introduced tree, but it yields an intensely bitter bark, which Dr. Robert, of the Chinese Naval Department, in 1874, found very useful for dysentery, and which Professor Hetet has recommended as an active vermifuge. It is said of this tree that its leaves afford food for the silk-worm (**Attacus cynthia**), while it checks the spread of the rose-bug, to which it is destructive. The third species is **A. malabarica**, *D.C.*, the *Perumarum* of South India, which yields a rather fragrant resin named *mutipal*, useful, when purified, as a substitute for Venice turpentine. The word "ailanthus" is latinised from "*arantha*," the Malayalum name of the last-mentioned tree.

Medicinal uses of bark and leaves.

The bark and leaves of **Ailanthus excelsa** are in great repute in Madras, and have received favourable notice from Drs. Ainslie and Wight. In the Telugu country the bark is regarded as a powerful febrifuge and tonic in cases of debility. It is also good for dyspepsia and bronchial and asthmatic complaints.

Laboratory test.

The only notice of a chemical examination of the bark appeared in 1870,* when Mr. Narain Daji read a paper on the subject before The Grant College Medical Society of Bombay. Mr. Daji separated an acid principle which he named ailanthic acid. It was reddish brown, very bitter, forming a deliquescent mass of waxy consistence, easily soluble in water, less so in alcohol and ether, and insoluble in chloroform and benzol. He also found a bitter, non-crystallisable principle, but he attributed the

* *Pharm. Journ.* [3], Vol. I., p. 154.

AILANTHUS excelsa.

Bark of Ailanthus excelsa.

medicinal virtue to ailanthic acid. In doses of 1 to 3 grains it was said to be tonic and alterative. In larger doses it caused nausea, vomiting, and purging. He strongly recommended its use in dyspepsia with constipation.

Objects of the present examination.

An authentic sample of the bark having been supplied by Dr. Watt of Calcutta, I proceeded to make an examination of it to confirm, if possible, the presence of ailanthic acid, and to ascertain more definitely the nature of the bitter principle.

The bark was in flattish pieces about 6 inches long by 3 to 4 inches wide, and half an inch thick. It was light coloured and granular in texture; externally hoary and rough from the presence of numerous longitudinal scabrous ridges, internally, yellowish white and finely fibrous. When soaked in water the bark swelled and became glutinous on the surface. The odour is acrid and mawkish; the taste very bitter. The bark contained a large number of stony cells collected together in groups, and many conglomerate raphides. The ash of the air-dried bark amounted to 7·4 per cent. Starch was present in the medullary rays, but no tannin was discovered. Dr. Mohideen Sheriff in his *Materia Medica of Madras* stated that the bark of **A. excelsa** is distinguished from that of **A. malabarica** by a decoction of the former blackening the persalts of iron. My experience of the barks in question is that they are both free from tannic acid.

Several ounces of the powdered bark were macerated for a week with rectified spirit and then percolated to exhaustion. The percolate was distilled to recover most of the spirit, and the residue was gently evaporated to a syrupy consistence. No crystalline matter appearing, evaporation was continued to dryness, when a brownish-red acid and bitter residue was left. Water formed a light-coloured solution of the bitter principle, and this extract being naturally acid it was shaken with ether and other solvents, which removed a waxy, brown body, not bitter, and insoluble in water in a free state. After this treatment the aqueous solution was found not to be disturbed by alkalies, but to give precipitates with iodine tannin and lead acetate; in the latter case the bitterness was left in the soluble portion. Some more of the solution was treated with freshly-prepared tannin liqour until a precipitate ceased to be formed: this was collected on a filter and washed. This precipitate was mixed with fresh lead hydrate, and the whole dried at a low temperature. The dried tannin compound was powdered and boiled with successive portions of alcohol, and the blue fluorescent liquid was evaporated. The residue was a light-brown granular substance, not distinctly crystalline, intensely bitter, neutral in reaction, soluble in water and spirit with a fluorescence, not readily soluble in ether, but distinctly so in chloroform. It gave a purplish colour with sulphuric acid, and yellow with nitric acid. Its solution was precipitated by iodine in potassium iodide, potassio-mercuric iodide, and tannin. The bitter principle was not shaken out of acid, neutral or alkaline, solutions by ether or chloroform. The spirituous extract of the drug also contained a fatty substance, a resin, and a body freely reducing Fehling's solution.

Deductions therefrom.

From the above examination it would seem that the bitter principle of **Ailanthus excelsa** bark has no claim to be called an acid, but rather to belong to a neutral class of substances related to quassiin. Although not obtained in a distinctly crystalline condition, perhaps by working on a larger quantity than I had at my disposal, crystals could possibly be separated by this or another method. The fluorescence of its solutions, the abundant precipitate it gives with tannin, and the purplish colour it

communicates to strong sulphuric acid, are characteristic of the bitter principles of many plants of the SIMARUBACEÆ. The cedrin obtained by Lewy in the seeds of **Simaba cedron**, the principles separated by Warden from the wood of **Picrasma quassioides**, and by Shimojama and Hirano from **P. ailanthoides**, and the samaderin from **Samadera indica**, may on more complete analysis prove to be one and the same active principle, and that principle quassiin.

G. I. C. P. O.—No. 976 R. & A. D.—24-7-96.—2,100.—H. R.

(Entomological Series, No. 5.)
(Sericulture.)

THE

AGRICULTURAL LEDGER.

1896—No. 26.

SILK.

(BURMA SILK.)

[*Dictionary of Economic Products, Vol. VI., Pt. III.*, S. 1829.]

THE SILK INDUSTRY IN MAGWÈ DISTRICT.

Note by C. W. ALLAN, ESQ., *Extra Assistant Conservator of Forests.*

The following note which is published by the courtesy of the Burma Administration will, it is thought, be found worthy of attention by those engaged in the rearing of silkworms:—

TAUNGDWINGYI.

It may be of interest to know that the inhabitants of the following villages in the Taungdwingyi subdivision make their living by silk culture:—

Localities where silk culture is practised.

Thetkemyaung.	Kyogyaung.
Kalama.	Taikpwe.
Saidaw.	Kyauktaung.
Gônnyindan.	Sinchidaing.
Kyangya.	Thôngwa.
Chizèaing.	Thabyeaing.
Nyaunghmaw.	Taungyaung.

Race and origin of Silkworm.

The worm, I believe, is what is known as the Chinese variety, and I understand the eggs were first brought into this country from China.

Description. *Conf. with p. 6.*

The villagers tell me it takes eight days for the eggs to hatch. The caterpillars moult four times. When the worms first hatch they are of dark colour, but after their first moult, which begins on the sixth day, they leave their old skin on the eighth a whitish colour. As stated above the caterpillars moult four times, the moults beginning on the 6th, 14th, 22nd, and 30th days after hatching. They lie dormant two days each time. After their last moult they feed for 12 days, turn yellow, then begin to spin their cocoons, thus remaining in its caterpillar stage for 44 days.

SILK.	The Silk Industry

TAUNG-DWINGYI.

Mode of rearing Silkworm.

When the worms hatch out they are put into round tray-like baskets without covers called *sagaws*. When young they are kept covered over with a cloth because the blue-bottle fly called the *pyin* stings and kills them; but when the worms get older they are kept open, as the flies do not trouble them then. The *sagaw* is 3 feet 5 inches in diameter and 3 inches in depth; the mulberry leaves are plucked and laid in the *sagaw*, and the worms are put on the leaves; they are fed three to four times a day.

From 800 to 1,000 worms are kept in a *sagaw*. When they turn yellow they are taken out of the *sagaw* and put into a larger tray called a *phine*, which is 5 feet 5 inches in diameter and 1 inch in depth. Circular compartments are made in the *phine* with what is called the *phine-oo*, which is a mat of bamboo about 3 inches in breadth and about 30 feet in length; this is put into the *phine* in spirals about 3 inches apart.

Preparation for spinning.

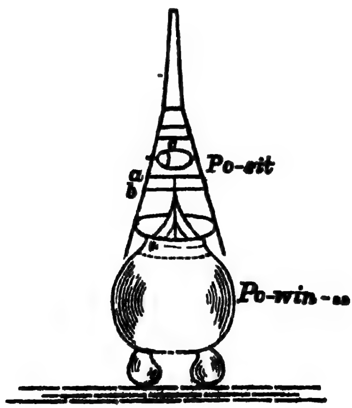
Three days after the worms are put into the *phine* the cocoons are ready; they are then taken from the *phine* and put into a basket or kept in a *sagaw* for three days, making six days from the time of spinning, by which time the worm inside the cocoon has turned into a pupa.

Silk spun from cocoons while boiling.

The cocoons are then taken and put into a chatty with hot water and kept on the fire and the old lady of the house sits by and spins; the silk while it is boiling,

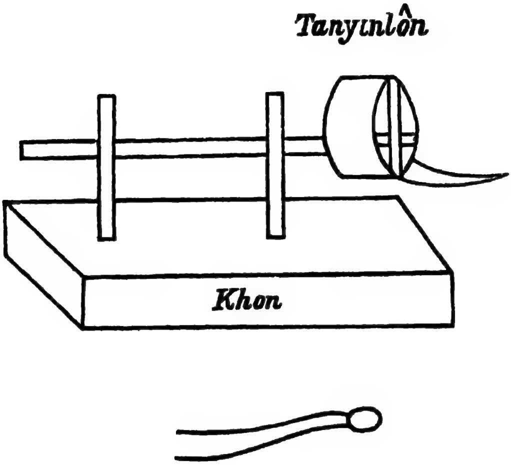
Spinning.

The chatty in which the cocoons are kept is called the *po-win-oo*; on to this is fixed the *po-sit* with a rough bamboo wheel, over which the silk is passed and spun on to the *tanyinlôn* or wheel, which is fixed to the *khon* or frame.



TAUNG-DWINGYI. Spinning.

The lady sits by with a small pair of iron tongs and picks up from five to seven cocoons in her hand and detaches a few threads and passes them in and out of the cross-pieces marked (*a*) and (*b*) and gives them a wind round the wheel marked (*c*) from which it is taken and turned round the *tanyinlôn*; the *hnyat* or tongs are used to keep the cocoons from leaving the chatty or *po-win-oo*,



Thus all the silk is wrapped off and the worms, or rather pupas, are left in the pot in a boiled state; they are then taken and fried and eaten and are considered a great delicacy among the Burmans.

Price realised for silk when spun.

Six *sagaws* give 1 viss * of silk, which is sold at R16 a viss to people of Taungdwingyi, who come and buy it in the jungle villages.

The refuse silk taken from the ends of the cocoons is spun by hand and sold at R10 a viss. Some of the cocoons are kept to breed more worms; these turn into moths and come out of the cocoons about the eighth day after spinning. The moths, male and female, are put into a *sagaw*, where they copulate.

Rearing.

After the male separates from the female, the females are taken and put into a bin, made out of the leaf of the toddy-palm. The bin is about 3½ inches in diameter and 1 inch in depth; these bins are put on to some Chinese paper and 25 moths, females, put in each bin; the moths lay their eggs in a day and a night and are then thrown away. Ten bins are sold for R1; those who want to breed silk-worms buy the eggs.

Price of seed.

* Viss = 3·6 lb av.—*Ed.*

SILK.	The Silk Industry in Magwé District.

TAUNG-DWINGYI.

Destination of silk and eggs.

A large quantity of the silk and eggs are taken across to Swa, on the railway line, on the Pyinmana side, and sold there.

The mulberry plant, on the leaves of which the worms are fed, is cultivated from cuttings. The mulberry gardens are, for preference, made along the beds of streams, where the kine grass is cut and burnt and the cuttings planted; but where there is not sufficient room, the cuttings are planted in *yas* on the hill-sides.

The mulberry how propagated.

The gardens are kept up from two to five years. When the plants grow big and do not give much leaf they are cut down and thrown away and fresh cuttings planted in a new *ya* as the plants bear most leaves when young.

Conf. with p. 1.

Specimens of the silkworm described in the foregoing note, together with moths and empty cocoons, have been received from the Conservator of Forests, Western Circle, Upper Burma.

Conf. Dict. Econ. Prod. Vol. VI., Pt. III., S. 1727 and 1747—1759.

These prove to belong to the species **Bombyx arracanensis,** *Hutt.*

S. 1829.

G. I. C.P. O.—No. 197 R. & A. —21-8-96.—2,100—W. B. G.

(Vegetable Product Series, No. 26.)
(Edible Substances.)

THE AGRICULTURAL LEDGER.

1896—No. 27.

CAMELLIA THEIFERA, *Griff.*

(LETPET TEA.)

[*Dictionary of Economic Products, Vol. II.*, C. 244-256.]

Review of the Recent Correspondence on the Letpet Tea and the Tea Plant of Burma, by the Reporter on Economic Products to the Government of India.

LETPET TEA.

During the past two or three years considerable interest has been taken in the subject of the Wild Tea Plant of Burma and in the peculiarly manufactured article known in Burmese trade as *Letpet* (or *Leppett*) Tea. Some portion of the correspondence on the latter subject has already appeared in the *Kew Bulletin* (No. 109, January 1896), but the further particulars since to hand would seem to justify the publication of a more complete review of the official communications, that have passed between the Governments of India and Burma. The notice of *Letpet* Tea as given in the *Kew Bulletin* opens with a few brief sentences on the previous papers that had appeared in the *Bulletin* on other special tea preparations somewhat akin to *Letpet*. These are the *Pu-êrh* of Yun-nan; the Brick Tea of Tibet; and the *Lao* of Upper Siam. It is proposed to confine attention in the present review to the available information on *Letpet* Tea and to the Wild Tea Plant of Burma. The interesting correspondence that also exists on the subject of Brick Tea may form the subject of a further review at some future date.

Review of Recent Correspondence

WILD TEA OF BURMA.

Indian Tea Planters* may possibly find some of the particulars given below more than amusing. The methods of cultivation, plucking and pruning pursued in Burma may very possibly afford useful hints and Mr. J. C. Murray's Report will be found of special interest. It would not surprise the writer very greatly were the system of steaming the leaves found capable of adaptation to the European method of manufacture. The experience of centuries that suggests the opinion that after a certain period tea bushes become less productive, may fairly well be regarded s worthy of careful consideration by the European planter whose accumulated knowledge hardly covers the period fixed in Burma as that of healthy and profitable production.

Steaming Leaf. *Conf. with pp. 6, 10, 26, 29-30.*

Age of Bushes. *Conf. with pp. 10, 28.*

Indigenous or Acclimatised.

The discussion as to whether Camellia theifera is indigenous to Burma is the old old story upon which Assam Tea Planters will be found to range themselves on opposite sides, in nearly equal numbers, the one party claiming the tea plant as indigenous to Assam and the other affirming that the wild plants met with in the forests are but survivals of an ancient cultivation. This difference of opinion is, however, very frequently one of a mistaken notion that when a plant may be described as wild, that is to say, self-sown and requiring no protection from man, it can be regarded as indigenous. A Planter will sometimes point with indignation to the fact that the tea plant grows wild in this forest and that, when doubt is being thrown on his views as to the botanical meaning of the word indigenous. There is unfortunately something more required, before a plant can be regarded as indigenous, than its mere existence in forests even remote from present cultivation. Mr. Bruce (*p. 20 below,*) would seem to think that the tea plant came from Burma to Assam and Manipur even although he denies that it is indigenous in the parts of Burma explored by him. But even were Mr. Bruce able to prove that certain invasions of Assam by the Burmese, transported the industry of tea-planting, that would no more disprove the idea of the plant having all the while been indigenous to Assam than that it was not indigenous there, because Lord William Bentinck (1835 to 1839) brought it from China. Nevertheless there are many circumstances in Manipur and the Naga Hills that induce me (at all events) to believe that the plant is truly indigenous in these regions as it may also be in some portions of Assam proper and in Burma. And I make this statement now, some years after the date of the publication of my chapter on Tea in the

Introduced into Assam from Burma.

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Dictionary of Economic Products, because my recent explorations in Assam and the Naga Hills fully satisfy me that I was correct, in my original view, based as it was *mainly on a botanical exploration of the tea area of Manipur.* There is, however, little to be gained by extending a controversy that can but be said to aim exclusively at localising within narrower limits the home of the tea plant. All writers are agreed that it is indigenous to the tract of hilly country that constitutes the border land of Assam and Burma with China.

Wild Tea in Manipur. *Conf. with p. 20.*

There, is, however, a practical aspect to the controversy. In one of my letters below it will be found that I have urged the desirability of a more careful study of the "wild" tea plant with a view to discover whether or not it is subject to any of the great tea blights that are causing so much injury to the tea-planting industry. The samples received by me from Burma, so far, have revealed the existence of only one vegetable parasite, a **Loranthus**, that in Assam seed gardens does some injury. The specimen sent to me as that of a white fungus proved to be the white scale insect (**Aspidiotus transparens**) well known in tea gardens, but which does very little injury to tea cultivation. One specimen also, a boring insect, was obtained from Burma which very possibly is the well-known enemy of both the tea and the coffee plant, *viz.*, **Zeuzera coffeæ**. I have received no samples that would indicate the existence in the "wild" nor in the so-called cultivated tea of Burma of any of the great blights of the tea plant, such as mosquito, red spider, green fly, thread blight, grey blight, red rust, blister blight, etc.

Practical Aspect.

Conf. with p. 16.

It might help forward very greatly the question of the alleviation of the destruction caused by these blights, were we in a position to affirm conclusively that they were a consequence of cultivation and not necessarily enemies of the wild plant. With that object in view I personally explored the forests (and seed gardens within these forests) that fringe the area of tea cultivation in Assam. I also extended my researches into the Naga Hills and examined there several large expanses of what I regard as indigenous **Camellia theifera**. I found only one of the tea blights, an **Alga.*** This appears on the leaves as small red patches. In that condition it is harmless being a purely epidermal parasite. Unfortunately for the Planters, however, it has the power to assume a second condition, becomes deep seated within the tissue of the young

Pests, a consequence of Cultivation.

"Red Rust."

* **Mycoidea parasitica**, *Cunningham.*

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shoots and is then known as the very dangerous "Red Rust." There is not a tea garden in all Assam, I confidently affirm, that does not possess the leaf-parasite condition of this **Alga.** Fortunately it only rarely appears in its second form and the conditions that induce this change in the life of the **Alga** are exceedingly obscure. But in the wild or so-called wild tea of Assam and the Naga Hills I failed to find any evidence of the "Red-Rust" condition. And what is still more significant, while I found the leaf-parasite form, on many other wild plants, I failed to discover on any of these the "Red Rust." If this observation be confirmed by others, for example in Burma, it might be regarded as indicating a change in the life of the **Alga** favoured by the special adaptations of the cultivated tea plant. But why it should appear, in its dangerous form, in certain districts of the Assam tea area and not in others, immediately adjacent, is a problem of the greatest obscurity. Should by any unforeseen circumstance, the germs that exist in every garden change from the one condition to the other "Red Rust" would assume a truly alarming aspect and it cannot be said this is an impossibility.

Forms or Races of Camellia theifera.

But I have alluded to the example of Red Rust purely and simply with the object of indicating the value to the tea-planting industry of a more extended and careful study of the wild plant. There is still another possible aspect of the advantages to be attained by a botanical investigation of the Burma wild tea plant. **Mr. Bruce** affirms that a large proportion of the recent tea extension of Assam* has been planted with Chindwin seed. In several of the other communications on this subject it is affirmed that the Burma plant is identical with the "Assam indigenous." In my opinion the two plants are perfectly easily recognised, have in Assam distinct properties, and are undoubtedly separate races of the **Camellia theifera** of cultivation. I should place the Burma plant as a race much nearer to the so-called Assam hybrid plant than to the pure Assam indigenous.

Conf. with pp. 21, 33.

Selection of Seed.

The Chindwin seed has been found like the Manipur and Cachar suitable to some districts of Assam and has practically failed in others. It follows, therefore, that when greater attention is given in the future to the selection of seed, the properties of the wild plants of each area will become very important subjects of study. To regard them as identical, on the botanical bases of **Camellia theifera,** would

* Does he mean Cachar?

be on a par with the view that the Cabbage, Cauliflower, Green Kale, Savoy Cabbage, Brussels Sprout, Koli Rabi and Brocoli, were one and the same cultivated plant, because they had all very possibly been derived from the **Brassica oleracea** of Botanists. There can be no doubt that the so-called wild **Camellia theifera** of the forests of Assam has properties and peculiarities of its own, distinct from those of the **Camellia theifera** of Manipur, or of the **Camellia theifera** of Burma, and quite as much so as from the **Camellia theifera** of China. But what is more surprising still the produce of the various seed-gardens of Assam manifest the most marked diversities. Is it to be wondered at, therefore, that the Burmans should recognise the difference in flavour from the cultivated, as compared with the so-called wild plant? It would indeed be contrary to all experience were it not the case that a cultivation extending over centuries, however crude it may be, should not have produced in Burma a distinct race of the plant—perhaps quite as distinct from the neighbouring wild tea as from any of the other well-known races of the plant in other parts of the tea area. To suggest, therefore, that wild seed should be collected and sold mixed with the cultivated stock, would very possibly result in an evil name to all Burma tea seed. Too much care in keeping the seed of each locality separate cannot be shown, and wild tea seed if at all possible should be declared separately from cultivated. Burma is an area large enough to afford several distinct races of the plant, and the longer the study of these is delayed the less chance is there of good results being obtained. I should not be surprised to find that the habit, described by **Mr. J. O. Murray** (*p. 26 below*), of dipping the leaves into boiling hot water instead of steaming them proceeded from the fact that the two plants on the East and the West of the Irrawaddy belonged to widely different races that could not be cured by the same process.

Conf. with pp. 17, 18, 21, 24, 27.

Wild and Cultivated Seed mixed. *Conf. with pp. 22, 23.*

It is in my opinion, by the selection of seed, that the chief reforms of the industry will be effected, and I have therefore in these remarks purposely diverted from the curiosity *Letpet* to that of the Burmese Tea Plant. The supply of improved and carefully selected seed might easily become a large and profitable industry, but with the extension of railway communication, Burma will doubtless develop into a greater rival to Assam than any of the other tea districts of India are very likely to become.

Selection of Seed. *Conf. with p. 18.*

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"Leppett" Tea.

From C. G. Bayne, Esq., I.C.S., Revenue Secretary to the Chief Commissioner of Burma, to the Secretary to the Government of India, Department of Revenue and Agriculture,—No.—49—5-A.—10, dated Rangoon, the 4th July 1894.

In continuation of this office letter No. 120—5-A.—10, dated the 7th May 1894, I am directed to submit, for transmission to Her Majesty's Secretary of State for India, seven packets containing samples of the "*Leppett*" tea of Burma. Four packets contain wet "*Leppett*" and three packets dry "*Leppett.*" Two specimens of the plant (**Elæodendron orientale**) are also submitted. A copy of a note by **Mr. W. A. Graham** containing information regarding the tea is enclosed.

Information regarding the "Leppett" *Tea of Burma by* **Mr. W. A. Graham.**

1. By far the greater quantity of the tea consumed by the Burmese, called "*Leppett,*" is grown in the Yaung Baing State of the Northern Shan States. This State is entirely given up to the cultivation of the tea tree, and the inhabitants one and all, including the Sawbwa himself, trade in the commodity.

2. The gardens are situated on the hill-sides, which, in this neighbourhood, are very steep. The trees continue to yield crops of leaves suitable for the market until they reach maturity and a height of some 60 feet, but the best article is obtained from the young shrubs, of which the gardens chiefly consist. Two crops of tea are secured each year, one in May and one in July, only the young and tender leaves being taken. The leaves, while still green, are boiled in large narrow-necked pots made for the purpose. When thoroughly boiled the contents of the pots are turned into large pits dug in the ground. These pits are square and about 6 feet deep; the sides and bottom are lined with thin walls of plantain-leaves, which keep the tea pure from contact with the earth. The pit being full of boiled tea and the juices from the pots, a top made of plantain-leaves is placed over it and earth is piled above it, big stones and other heavy weights being finally placed on the top.

Tea Leaves Boiled in Manufacture of Letpet.
Conf. with *p. 9, 11, 20, 30,*

3. The tea is thus preserved and compressed for some months, when the trading season coming on, the pits are opened and the tea

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is sold to the traders, who come with their caravans of bullocks and carry it away to the Mandalay market. For transport the tea is packed in long baskets, of which each bullock carries two. The baskets have no lid, but are covered in with strips of bamboo, so arranged as to serve the purpose of a lid in being air-tight, and at the same time to admit the insertion of a wedge, the pressure of which prevents fermentation from setting in. Every day the wedges are hammered in a little further, so that, although the tea dries in the baskets and shrinks, a constant pressure is kept up.

Price of Letpet.

4. The price of the tea at the gardens ranges from R15 to R25 per 100 viss.* When sold to the brokers in Mandalay it fetches from R60 to R100, or even to R140, per 100 viss. As the tea loses weight a good deal in transit from Yaung Baing, the traders on nearing the market usually throw the baskets for a day or two into the nearest stream, by which simple process the article is made to recover its lost dampness, and weighs as much as it did when purchased. In Upper Burma and the Shan States a good deal of this tea is consumed as a drink, for which purpose it is sold in a dry state. It is prepared by boiling it in an earthen kettle and is drunk with salt. The greater bulk, however, is sold by the Mandalay brokers to merchants in Lower Burma, where it is largely consumed in the solid. The leaves are soaked in oil, a little garlic, dried fish, etc., added, and the concoction thus formed eaten, being considered a great dainty. Besides being regarded as a dainty, however, the "*Leppett*" is a traditional food among Burmans. At the important junctures of a man's life, such as birth, initiation into the church, marriage and death, "*Leppett*" plays an important part, and no ceremony is complete without the consumption of that article. The tea remains in the same basket from the time it is bought at the gardens until it is sold by the merchant to the actual consumer. Large numbers of baskets are to be seen at every wharf along the Irrawaddy banks and in the bazaars throughout the country.

The further investigation into the subject of *Letpet* tea having been transferred to the Reporter on Economic Products, the following letter

* Viss = 3·65lb av.

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was addressed to the Revenue Secretary to the Chief Commissioner of Burma :—

From the Reporter on Economic Products to the Government of India, to the Revenue Secretary to the Chief Commissioner, Burma,—No. 770, dated Calcutta, the 23rd August 1894.

I am directed to acknowledge receipt of your No. 49—5 A., dated 4th July, together with the enclosure—a note on *Leppett* or *Letpet* tea by Mr. W. A. Graham and accompanied with certain samples of the tea.

2. I am to inform you that the two botanical samples arrived in a state of complete decomposition. Some 50 plants had been pulled out by the roots and packed while green into an almost air-tight box. The result might have been anticipated. But the rotten twigs have revealed one point of importance, namely, that the leaves had originally been alternate in which case the plant cannot possibly be a species of **Elæodendron** and for other reasons cannot belong to the Natural Order to which that genus is referred. The name **E. orientale,** *Jacq.*, is that of a Madagascar plant and which is not likely to be in Burma. It is not a synonym, therefore, for the common Indian species **E. glaucum.**

3. I refer to these botanical considerations because you will observe Mason in his *Burma and Its People, page 505*, says the *Letpet* tea is obtained from that plant. While collecting material for the two articles on tea that have been given in the Dictionary, I came to the conclusion that Mason was most probably incorrect in that view and that the *Letpet* was very possibly a peculiarly prepared article made from the ordinary tea plant. Reference has, therefore, been given to this subject under **Camellia theifera,** *Volume II., pp. 74-76*, and again in the article Tea, *Volume VI., Part III., p. 449*. I mention these passages because it will be found that the opinions quoted give an account which differs slightly from Mr. Graham's description. At the same time Mr. Graham's specimens, though absolutely useless for any botanical purpose, have sufficed to confirm the opinion formed by me some years ago, *viz.*, that when the subject of *Leppett* tea is gone into it will be found that it is not an **Elæodendron.** While this view may be confidently advanced as correct the determination of the plant is a matter of absolute uncertainty. It may be **Camellia theifera** or possibly **C. drupifera,** or it may be an altogether different plant. The only point that can be made out is that it is not an **Elæodendron.**

Determination of Letpet Plant.

4. Under these circumstances I am desired to inform you that the samples of prepared *Leppett* Tea furnished by you have been forwarded to Her Majesty's Secretary of State for India, but that in the Despatch accompanying these it is stated that proper botanical specimens shall be procured and transmitted to London at a later date. I am therefore to ask that you may be good enough to direct the person employed to prepare these samples, to cut off twigs, say, 12 inches long with leaves and flowers (or if flowers be not in season, fruits) and to place these between sheets of blotting paper and to change the blotting paper day by day, supplying fresh dry paper each time, until the specimens are completely dry.

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If the plant be neither in flower nor fruit at present, one or two twigs dried (as briefly described) would enable me to form some conception of its nature and better samples might be furnished when both flowers and fruits are obtainable. I need hardly add that the subject is of the very greatest interest to the Tea Industry of India.

From the Revenue Secretary to the Chief Commissioner, Burma, to the Reporter on Economic Products to the Government of India,—No. 649—5A-11, dated the 28th June 1895.

I am directed to forward for favour of examination and report—

(1) Branches of tea with young fruit in Shan paper;
(2) Branches of **Loranthus** parasite in Shan paper;
(3) *Letpet* pickled tea in bamboo internodes;
(4) Tea seed in tin boxes, green and dry;
(5) Fruit of **Loranthus** preserved in rum in stoppered bottle.

I am to annex a copy of a report, dated the 13th March 1895, by Mr. Bruce, Assistant Conservator of Forests, upon this tea plant.

Report on the Tea Industry of the Upper Chindwin, by* C. W. A. Bruce, Esq., *Assistant Conservator of Forests, Upper Chindwin Division.

The following is a list of the villages of the Upper Chindwin which export tea-seeds, the inhabitants of all being Shans:—

Kaungkan.	Tasôn.
Tingin	Onbet.
Kawya.	Mainwe.
Maungkan	Tamanthe.

Malin.

Seed Production Chief Income.

Tradition says that these *kins* (clearings) were cleared and planted some 200 years ago, the seed having been brought from Palaung (Northern Shan States). No one has ever heard of wild tea in the jungle; the gardens were originally planted for the sake of the leaves, that is, to make "*letpet*," the so-called pickled tea of Burma. However, some 20 years ago there arose a demand for the seed, at first intermittent, but since British occupation steady, and this has now become the main source of income to the owners, though the pickled tea is still collected and made as of old.

Red Soil Preferred. Conf. with pp. 25, 28.

Method of Planting, etc.—The first thing to be done in planting a *letpet-kin* is to find the right kind of soil, what is known as *myeni*, literally red earth. In this soil the tea-tree flourishes to perfection; the look of this earth is very characteristic, being a light red or buff-

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coloured friable loam, which occurs in patches, and wherever these patches of red earth are found on the banks of the Chindwin there villages have been built and tea planted.* The jungle being cleared of all brushwood and undergrowth, three or four seeds are dibbled into holes, the holes being either two or four cubits apart. The object of dibbling in more than one seed is to guard against blanks; however, all the seeds that germinate are allowed to grow. After the plants come up all the tending the gardens receive is periodical clearing of grass, small plants, weeds, and brushwood; the ground is never hoed nor the plants pruned, except when the ravages of a parasite known as *Chibaung* have become so extensive as to kill the portions above ground; the dead tops are then hacked down with the ordinary Burmese *dama*, the plant at once throwing up stool shoots or root-suckers which in three years take the place of the old cut-down plant. The small plants become large enough to give a crop of leaves in three years if the *kin* is kept free of jungle, but not till five years if the garden is "dirty." Seed is borne when the plants are eight years old, but they do not come into full bearing till 15 years of age, the normal existence of a tree being 40 to 50 years, if not attacked by the parasite mentioned above. Some trees last longer than this, but old trees do not bear such good crops of seeds or leaves as middle-aged ones, being usually stagheaded, and are generally cut down, their places being taken by vigorous shoots thrown up by the stools, some stools as large as three feet in girth being seen. A light shade is beneficial to the plants and lessens the labour of keeping the gardens clean, as the shade kills out the rank grasses, such as *thekké*, etc, which spring up if there is no shade. Heavy rains are not good for the seed-crop, as the seeds drop off without ripening; however, if the seed-crop is poor, the leaf-crop is usually good, and *vice versâ*.

Seeds Dibbled.

No hoeing. No pruning.

Colar pruning .old Bushes.

Old Trees give Inferior Crops.

Conf. with pp. 9, 98.

Shade Desirable.

Conf. with p. 98.

Ownership.—Each house owns from one to three *kins*, the various properties being bounded by rough cactus hedges.

Crops.—As already stated, there are two kinds of crops—the leaf-crop and the seed-crop—

(*a*) *The leaf-crop.*—The trees flush three times a year in—

(1) Tagu to Kasôn (April—May);

* The soil in Manipur and the Naga Hills on which wild tea occurs answers admirably to this description.—*Ed.*

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Method of Plucking.

(2) Wazo to Wagaung (July—August); and

(3) Tawthalin to Thadingyut (September—October).

Of these three flushes the first gives the best leaf and brings the highest prices. The method of plucking is to pluck the whole shoot except one leaf which is left. Thus if there are three leaves in a shoot, the shoot is nipped off just below the second leaf. Each owner then takes his crop of leaves and throws it into an iron cauldron* full of boiling water; it is left in this water till the leaves turn a yellow colour; the water is then thrown away and the leaves rolled by hand on mats; it is then ready to be sold to traders, who take it away either packed in bamboo crates or in the internode of the *myetasangye* bamboos (**Dendrocalamus Hamiltonii**). If one wanted to keep this tea, it must either be kept buried in the ground or the crates and bamboos must be kept in water. Kawya village, which has the largest extent of *kins*, makes on the average 20,000 viss of *letpet* annually. The price at the village for the produce of the first flush is usually R16 per 100 viss, for the other and later flushes R12-8-0 per 100 viss.

* The ordinary *dé* of Burma, similar to the one cutch is cooked in.

Leaves thrown into Boiling water.

Conf. with pp. 2, 6, 26, 80.

Seed-crop.—The seed-crop ripens in October and November; it is then collected, dried in the sun and sold to Burmese traders, who come up for it. The trader shoots the seed into the bottom of his boat, the bottom being roughly lined with mats, and then takes it down to Kettha or Tônhè; where he sells it to the native agents of "tea-seed chiefs."

System of Purchasing Seed.

Value.—The price of the tea-seed on the garden varies from R3 to R10 per basket, but to understand the method of buying the seed one must bear in mind that the trader, always a Burman, comes up in January or February to bargain for the seed-crop of the following November. If possible, the trader makes a contract that the owner will sell him all the produce of the garden for a fixed sum per basket. Thus in January 1894 the Maungkan villagers contracted to sell all their seed at R5 a basket. The trader then advances on the condition that, if the villagers cannot pay him back in tea-seed, they must pay him R100 per cent. on his money. If the trader cannot get a contract for the whole crop, he always manages to make advances for a certain proportion of the crop on the same condition. Thus, this year all the villagers of Kawya have had advances on the condi-

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tion that they pay back next November (in seed), each basket to be counted as R3. Any left after the villagers have paid back their advances usually brings double the contract price. The trader then hires boats and takes the seed to Kettha or Tônhè, the rate of boat-hire being from 2 annas to 4 annas per basket according to distance at Kettha. He will sell to agents of the tea-planter for an average of R17 per *maung* (a maung = 1 basket* 10 pyis or 26 pyis). This is practically the end of the business as far as Burma is concerned, as from here it is carried by Chin or Manipuri coolies in baskets, Scotch fish-wife fashion, to Manipur. No tax is collected or any transit dues exacted anywhere along the route. The Chins are said to carry a load of one basket-and-a-quarter, the average weight of one basket being 14 viss, and get R5 to R6 for the journey.

nsit om to ur.

Conclusion.—It will be seen that, as in most trades, the middlemen are the best off and absorb most of the profit. The Burman trader makes, even if he does not go in for the advance system, over cent. per cent., and of course his profits are doubled if he does. The Thaungdut Sawbwa has, I am told, petitioned the Government to be allowed to levy transit dues on the tea-seed passing through his State, though on what he bases his claim to the right, I fail to see. No Thaungdut coolies or men in any way are interested in the trade, the development of which is solely due to the Bengalis and Burmans. The Sawbwa's clerk, Maung Kyauk Lôn, alleges that the Sawbwa used to collect six annas per basket in Burmese times; this statement is false, according to every other person I have questioned. The only transit tax the Sawbwa has ever levied was one on boats and rafts passing Thaungdut town; this has of course now been long discontinued and had never anything whatever to do with the tea-seed trade. I believe Messrs. The Bombay-Burma Trading Company are experimenting as to the feasibility of sending seed to Assam *viâ* Calcutta; of course, if they succeed that will settle all matters of transit dues both for Thaungdut and Manipur. I see no reason why the Bombay-Burma should not succeed, as no care to prevent shaking, the effects of damp or of heat, is taken, any way prior to the seed reaching Manipur, by the present method, which seems to be as unscientific as possible, and yet the tea-seed has, as is

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* A basket of 16 pyis = 1 bushel.

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well known, a first class reputation in Assam for germinating properties. The tea-seed experimented with, however, I would recommend being bought at any cost in November; the best way of course would be to advance money on the following season's crop, this system being the custom, or else only the leavings and old seed which has been lying about can be got, which naturally would not have the same germinating power as fresh ripe seed.

Gardens wonderfully Healthy.

From what I saw of the gardens they were wonderfully healthy considering the little care taken with them, as, with the exception of the parasite referred to, the trees all seemed clean, vigorous and full of leaf. I should say tea-planting with European methods would be a great success if only the labour question could be successfully dealt with; that once settled, all a planter who proposed planting in the Chindwin would have to do would be to prospect for red earth, and from my own experience of the forests I am sure I have come across several tracts of similar earth to that on which the tea is grown. I enclose a specimen of the tea parasite.

Conf. with p. 5.

From the Assistant Curator, Indian Museum, to the Under-Secretary to the Government of India, Revenue and Agricultural Department,—No. 845—132, dated the 19th July 1895.

With reference to your endorsement No. 2245—97, dated the 21st August 1894, and subsequent reminder, I have the honour to state that the Chief Commissioner of Burma having supplied this office with fresh specimens of the plant from which *Letpet* tea is made, these, in the absence of Dr. Watt were sent to Dr. George King, Superintendent of the Royal Botanical Gardens, for determination. Dr. King has pronounced the plant to be **Camellia theifera**, thus confirming the opinion expressed by Dr. Watt, in his note dated the 2nd August, and in his letter to the Revenue Secretary to the Chief Commissioner of Burma, dated the 23rd August 1894, that the *Letpet* tea of Burma is made from the leaves of the true tea-plant (**Camellia theifera**) and not from an **Elæodendron**.

2. For compliance with the promise made in paragraph 2 of the Despatch to Her Majesty's Secretary of State for India, I beg to send herewith four specimens of the plant, lately received from Burma, and which has been identified as **Camellia theifera**.

From the Reporter on Economic Products to the Government of India, to the Under-Secretary to the Government of India, Revenue and Agricultural Department,—No. 945—132, dated the 3rd August 1895.

Determination of Letpet Plant.

In continuation of this office letter No. 845—132, dated the 19th ultimo, I have the honour to report that a further set of botanical speci-

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mens and samples of the *Letpet* tea have been obtained from Burma as follows:—

(1) A set of botanical specimens of the tea-plant (**Camellia theifera**) from which *Letpet* tea is manufactured in Burma.

(2) Two bamboo joints filled with *Letpet* tea.

(3) Two tins containing seeds of *Letpet* tea which, it is feared, are useless.

(4) **Loranthus** parasite which grows on the *Letpet* tea-plant.

2. I beg to forward, for perusal and return, a valuable note on the subject of *Letpet* tea and the trade at present carried on in tea-seed between Burma and India which has been furnished by Mr. C. W. A. Bruce, Assistant Conservator of Forests, Upper Chindwin Division. This with the approval of the Government of India, it is proposed, should be published as an issue of *The Agricultural Ledger* in which the whole subject of this correspondence would also be reviewed.

3. I have not forwarded a set of the specimens received since it is believed the Director of Kew would not now care to have more, the samples submitted along with this office letter quoted above having fully disposed of the object that existed for the supply of such samples, *viz.*, the determination of the plant which affords this form of tea. Should you think it desirable, however, that a further set of botanical samples of **Camellia theifera** should be sent to Kew, these can be either despatched to Simla or posted direct to London. The further supply of trade samples of the product have been mainly supplied in consequence of a requisition by this office for certain sets required by the Museum.

From the Reporter on Economic Products to the Government of India, to the Revenue Secretary to the Chief Commissioner of Burma,—No. 1006—139, dated the 18th August 1895.

Determination of Letpet Plant.

I have the honour to acknowledge with thanks the valuable report by Mr. Bruce on the tea-plant from which *Letpet* tea is manufactured, as also the specimens forwarded with your letter No. 642—5 A.-11, dated the 28th June last.

2. The specimens have been correctly named, and the mistake that hitherto prevailed about the source of the *Letpet* tea, being an **Elæodendron**, has now been removed; it is without doubt the true tea-plant (**Camellia theifera**).

3. I also beg to inform you that the permission of the Government of India has been solicited to re-publish Mr. Bruce's note as one of the series of *The Agricultural Ledger*, issued by this office. The subject of *Letpet* tea is one sure to be of interest to tea-planters in India.

From the Reporter on Economic Products to the Government of India, to the Revenue Secretary to the Chief Commissioner of Burma,—No. 109 C., dated the 11th October 1895.

Tea Diseases.

In continuation of the correspondence on the subject of *Letpet* tea and with special reference to your letter No. 642—5A.-11, dated 28th June

1895, I desire your kind assistance with reference to a remark that occurs in Mr. Bruce's report of the 13th March appended to your letter quoted above. Mr. Bruce speaks of a disease known as *Chibaung* that kills the tea. I am at present engaged on an enquiry into the subject of tea pests and blights and would like to be furnished with a few samples of the *Chibaung*, provided it is not the **Loranthus** alluded to in your letter above and of which you have already furnished me with specimens.

2. Should the *Chibaung* prove different from the **Loranthus** it would be most instructive to be supplied with botanically preserved specimens as also a few leaves and twigs kept in a bottle of spirits of wine.

3. I should very much like if you could invite Mr. Bruce or any other officer who may have the opportunity of doing so, to make a collection of all the insects and other pests found on the Burman tea or to dry botanical specimens showing fungoid or other diseases of the leaf, stem or root. It would be most interesting, for example, to know whether mosquito, red spider, thread blight, etc., had found their way to Burman tea. Without possessing any very technical knowledge of these diseases, an observant person might easily dry a few twigs that showed such diseases as are recognised by the cultivators. These, from my present knowledge, I could finally determine if fairly carefully preserved. The enquiry is more than of purely scientific interest. In tracing out the life histories of diseases questions of geographical distribution are often of vital importance. Certain of the tea diseases are apparently hereditary and as Burma has for some years past become a region of seed supply, it would be of no small value to know if the hereditary diseases occur in the Burma stock.

I shall be happy to furnish you with a report, should you so desire, on the samples of diseased tea that may be sent to me for determination. The **Loranthus** is nearly universal on all seed-tea, but its eradication by lopping off the branches on which it becomes established should be easily accomplished.

From the Revenue Secretary to the Chief Commissioner, Burma, to the Reporter on Economic Products to the Government of India,—No. 537—5A.-11, dated the 20th December 1895.

In reply to your letter No. 102 C., dated the 11th October 1895, I am directed to forward a copy of letter No. 1827—5 G.-1, dated the 7th December 1895, from the Conservator of Forests, Western Circle, together with the specimens referred to, and to say that the disease known as *Chibaung* is understood to be a **Loranthus**.

From the Conservator of Forests, Western Circle, to the Revenue Secretary to the Chief Commissioner, Burma,—No. 1827—5G.-1, dated the 7th December 1895.

With reference to your No. 586—5 A.-11, dated the 28th October 1895, I have the honour to state that on a late visit to the tea district in the

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Upper Chindwin with Mr. Bruce, we made careful enquiries in regard to the diseases which attack the tree there, and from what the inhabitants say it would seem to be very free from disease. An inspection of the gardens only brought to light a whitish fungus on some of the lower leaves which, however, does not cause them to fall off prematurely and does them but little harm.

Reputed Fungus.

We also found one branch bored with a grub, but in the course of a two-hours' walk through the gardens failed to find a second one. I am sending in a separate parcel the grub in the branch preserved in spirit and some leaves sprinkled with the fungus.

From the Reporter on Economic Products to the Government of India, to the Revenue Secretary to the Chief Commissioner Burma,—No. 169—132, dated the 29th January 1896.

I have the honour to acknowledge your No. 537—5 A.-11, dated the 20th December, by which you forward the letter No. 1827—5 G.-1, of the 7th December, from the Conservator of Forests, Western Circle, and two specimens of wild tea showing disease. In reply I have to say that of the four leaves supposed to show a white fungus, one is covered with the white scale insect (**Aspidiotus transparens**) and the others do not appear to show any fungus. May I, however, ask that a few more leaves or better still twigs with leaves, etc., showing this disease or any other spotted, stained or withered leaves, still adhering to the plant, may be supplied. Of each such disease I should like two sets of specimens prepared, one dried between blotting paper, the other preserved in spirits of wine. Leaves punctured or otherwise injured would enable me to discover if mosquito, green fly or any of the other great pests of the tea-plant existed in Burma. It is quite possible for a person not acquainted with the subject to regard the puncturing of leaves as an accident or to view yellow and brown spots on leaves as accidental circumstances and not the indications of serious diseases. The sample of scale insect already supplied shows that at least that disease exists on the Burmese wild tea and any circumstances that would lead to our being able to trace out the origin of the chief maladies of the tea-plant, I need hardly say would be of great practical value. The bottle with sample of borer appears to be **Zeuzera coffeæ**, an insect that often does much damage to tea gardens. Without having twigs supplied that contain cocoons from which the moth could be reared, it is next to impossible to name this insect for certain.

Scale Insect on Burmese Tea.

From J. W. Oliver, Esq., *Conservator of Forests, Eastern Circle, to the Revenue Secretary to the Chief Commissioner, Burma,—No. 347—18 E.-9, dated the 24th May 1895.*

In reply to your endorsement, Revenue Department, No. 534—8 A.-6, dated the 25th ultimo, I have the honour to inform you that I recently

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found a tree, said to be wild tea, growing in dense evergreen forest on the Taungmè range in the Bernardmyo reserve at an elevation of 7,000. The tree was an isolated one, about 4 feet in girth and 30 to 40 feet high. I did not notice any other trees of the same species, but I am informed that they occur here and there in the evergreen forests on the hills round Bernardmyo. I am not certain that the tea in question is identical with the cultivated variety grown by Burmans, but I have sent specimens of it to the Superintendent, Royal Botanic Gardens, Calcutta, for identification and will report the result. Tea is cultivated, I am informed, to a considerable extent in the neighbouring State of Mainglon (Thibaw) and the Lishaws near Bernardmyo have one or two small gardens. As far as I have been able to ascertain, the cultivated tea was originally derived from the wild form, but the leaves of the latter are said to be bitter and of no commercial value. As noted in the correspondence submitted with my letter No. 378—98 C., dated the 24th May 1892, wild tea is also said to occur on the Maingthôn hills in Katha; but considering the large number of tea gardens that exist in different parts of Upper Burma, it would hardly pay to collect seed from the wild trees, which, judging from the single specimen I have seen, only produce seed in very small quantities.

Leaves from Cultivated and Wild Tea.

Conf. with pp. 4, 18.

Wild Plant has bitter Leaves.

Seed of Wild Tea.

2. I have requested the Deputy Conservator of Forests of the Mu and Katha Divisions to make further enquiries in regard to the Maingthôn tea, and on receipt of their replies will submit a further report. I may add that the "*Chibaung*" alluded to by Mr. Bruce is probably a species of Loranthus.

From the Acting Curator of the Herbarium, Royal Botanic Garden, Calcutta, to the Conservator of Forests, Eastern Circle,—No. 136H of 1895, dated the 28th June 1895.

With reference to your letter No. 252—28 A.-2, dated 15th May 1895, forwarding specimens of leaves and unripe fruit of wild tea collected in the Ruby Mines District, I have the honour to inform you that the specimens now sent certainly belong to the same species, Camellia theifera *Griff.*, as those sent with your letter No. 3189—116 G. of the 25th February 1892.

From the Deputy Conservator of Forests, Katha Division, to the Conservator of Forests, Eastern Circle, Upper Burma, —No. 186—21 M., dated the 16th September 1895.

With reference to your office endorsement No. 361—18 E.-2, dated 27th May 1895, I have the honour to submit the following report:—On both sides of the Maingthôn hill there is a considerable quantity

Annual yield of Seed.

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Annual yield of Seed.

of natural sown tea-trees, estimated to be not less than 7,000 trees. It is estimated that about 2,000 baskets of seed could be procured here during the year. The inhabitants sell the leaves, of which the average annual outturn is estimated at 8,000 viss, chiefly from Thayet Kaing, Chaungson, Chaungbya, Maingthôn, Nwalabo, and Kangaw villages a basket of seed costs about R3. The fruit sets in July and is ripe in November. The above information is supplied by Forester Mg. Po Yin.

From the Deputy Conservator of Forests, Katha Division, to the Conservator of Forests, Eastern Circle, Upper Burma, —No. 2 C.R., dated the 5th December 1895.

In reply to your letter asking for further enquiries to be made with reference to the tea-plants on Maingthôn hill I have the honour to report as follows.

Not Cultivated.

From enquiries made there seems to be no reason to believe that the trees referred to in my original report are in any way cultivated. Near the foots of these hills close to Legyin, Gangaw, Kyauktaw and several other villages in the Wuntho and Banmauk Subdivision tea plantations do exist. These plantations are cultivated and kept up by different proprietors or villages: no use is, however, made of the seed produced in these gardens beyond small savings to replace dead or old trees. The leaves gathered in these plantations are sold on average price of 8 annas per viss.

The trees, however, referred to in my original report are spread irregularly over the forest either singly or in small clumps, they are of all sizes from 6 feet in girth downwards.

Leaves from Cultivated and Wild Tea.

Conf. with pp. 5, 17, 21, 23.

The collection of the leaves is from the younger and smaller trees only and is made by parties of men who go out for five or six days searching for them: each man in this time will collect 10 to 12 viss which only sell for 4 annas per viss or half the price of the leaves from the gardens. The collection of these leaves is not a regular industry, but is made from time to time by men who wish to earn a little money and who have nothing else to do. These trees are not held to be owned by any one man or even village though there are only some three or four villages sufficiently close to the forests to render the collection profitable.

C. 244-256.

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From the Revenue Secretary to the Chief Commissioner, Burma, to the Reporter on Economic Products to the Government of India,—No. 193—8 A.-1, dated the 6th June 1894.

I am directed to forward a copy of letter No. 354—36 A.-4, dated the 18th May 1896, from the Conservator * of Forests, Eastern Circle, regarding the occurrence of wild tea in the Maingthôn group of hills in the Katha district together with the samples of the specimens collected. A copy of each of the letters noted in the margin is also forwarded for information

* Letter No. 347—18 E.-2, dated the 24th May 1895, from Conservator of Forests, Eastern Circle, (*see p. 16*).

Letter No. 498—5 G.-1, dated the 6th June 1895, from the Conservator of Forests, Western Circle, (*see below*).

Letter No. 2029—18 E.-2, dated the 20th December 1895, from the Conservator of Forests, Eastern Circle, (*see p. 22*).

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From F. B. Dickinson, Esq., *Conservator of Forests, Western Circle, Upper Burma, to the Revenue Secretary to the Chief Commissioner, Burma,—No. 498—5 G.-1, dated the 6th June 1895.*

With reference to your letter No. 533—8 A.-6, dated the 25th April 1895, and No. 50—5 A.-11, dated the 3rd May 1895, I have the honour to forward a copy of Mr. Bruce's report from which it will be seen that it is improbable that there is any really wild tea in the Upper Chindwin or on the Maingthôn hills, and that therefore it is not possible to give a license for the collection of tea-seed.

2. It also seems certain from the report that the Chindwin plant is the **Camellia theifera.** Complete specimens will be forwarded as soon as they are received. In the meanwhile I am sending a specimen of a branch with leaves (but no flowers or fruit) which was sent me by Mr. Bruce at the same time as his report on the Chindwin tea gardens, but the steamer receipt was missent and only reached me a few days ago. On the branch is a specimen of the parasite mentioned by Mr. Bruce which is, I think, a species of **Loranthus.**

From C. W. A. Bruce, Esq., *Assistant Conservator of Forests, Upper Chindwin Division, to the Conservator of Forests, Western Circle, Mandalay (through the Deputy Commissioner, Upper Chindwin District),—No. 165—6 D., dated the 28th May 1895.*

With reference to your endorsement No. 215—5 G.-1, dated Mandalay, the 13th May 1895, I have the honour to inform you that nothing is easier than to say a thing does or does not occur in the forests, but nothing is harder than to prove one's statement however

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sure one may be in one's own mind. My opinion as to your questions is—

No truly Wild Tea West of the Irrawaddy.

(*a*) There is no such thing as true wild tea in the forest, *i.e.*, trees which have sprung up without the agency of man, nor is the tea-plant indigenous to the country west of the Irrawaddy.

(*b*) The *letpet* plant of the Chindwin is **C. theifera.**

My reasons for arriving at the above conclusions are as follows:—

1. Since my first arrival in the Upper Chindwin, I have been continually on the look out for wild tea. Now from my own observations, from answers got from old hunters who thoroughly know the forests, from my own guards, from thugyis and inhabitants of the country and from tradition, I am led to both the above conclusions. However, here I must call attention to the Supplement to *Burma Gazette*, 2nd July 1892, where Mr. J. W. Oliver states that he heard the tea in the Mansi (now Banmauk) subdivision had come from the Maingthôn, where it grew wild. This is also the country referred to by Mr. Jackson in his letter to the Principal Agent, Chief Commissioner, Assam, and I should say Mr. Oliver's published correspondence is the source of Mr. Jackson's statement. Now only last month I was through a part of this country and I was told the very same story as on the Chindwin, *i.e.*, that the trees had originally been brought from the Northern Shan States, and I believe the plant was introduced into Manipur and even into Assam itself from Burma, during the Burmese invasions of those countries, as though there is a great deal said about the first discovery of tea in the *Dictionary of Economic Products of India*, Volume VI., Part III., page 428, *et sequeter*, there is no satisfactory evidence given that the trees were truly wild ones. As for the statement, page 442, section 157, "and in Manipur it almost constitutes forests, the plants, attaining to the dimensions of trees," Major Maxwell in his diary for week ending 10th November 1894 says:—"The outturn of Manipur-grown seed will be almost 100 maunds and the Burma seed 1,500 maunds." If such forests occur, how is it that Manipur can export such a wretchedly small total of such a paying article as tea-seed? I have myself found tea growing in patches in the very heart of the forests. To give a case, there are four such patches in the Kanti reserve, Nankamu

Tea Plant Introduced into Assam.

Wild Tea in Manipur. *Conf. with pp. 2, 3.*

Burma Seed Exported through Manipur. *Conf. with p. 19.*

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stream, more than 15 miles from the nearest village. A casual observer finding these might jump to the conclusion that the trees were wild, but if carefully observed one can trace the hand of man in the method of planting, and such as has been my experience wherever I have found tea-trees.

Tea Prepared from Wild and from Cultivated Plants.

Conf. with pp. 8, 17, 18, 23.

2. As for pickled tea made from wild tea being more bitter in taste than cultivated, I some time ago enquired into this subject, having heard the same statement. Now what is meant by the Burman when he speaks thus is not that the tea is wild, but that it has been allowed to run wild; thus pickled tea made from bushes from which the flushes are seldom plucked, this accounts for Chindwin pickled tea being ranker in taste than Shan States pickled tea. The important crop in the Chindwin being the seed-crop, and the leaf-crop is more or less neglected, thus more tannin gets secreted in the leaves. The same holds good for the shoots of the *Mesalibin* (**Cassia Siamea**) and the tamarind, the shoots of both being used as a vegetable by the Burmans, who prefer to pluck the young shoots from trees frequently plucked than from a tree which is seldom or never touched.

3. The Deputy Commissioner, Kindat, informs me that the Thaungdut Sawbwa insists that there is wild tea in the forests of Thaungdut. I have myself been through the forests of the Thaungdut State from end to end on girdling work, and even beyond the confines of his State, and I must decline to believe the Sawbwa's statement until he can point me out a locality where it may be found growing wild.

As to the *letpet-bin* (plant) being **C. theifera** or not. Surely **Mr. Oliver** settled that point in the affirmative, even leaving out the fact that all the extensions of the Assam gardens have been planted with Chindwin seed for the last ten years at the very least.* However,

Conf. with p. 39. Assam Exports Tea Seed.

* From my personal knowledge of Assam tea plantations I should pronounce this a doubtfully accurate statement unless Cachar is meant. The new tea gardens and extensions of the past ten years are mainly in the so-called "Indigenous Assam" *obtained from the Assam tea-seed gardens*—a very small percentage may be in Burmese seed and still smaller in Manipur and Cachar. The further remark that the Reporter on Economic Products still seems to have doubts as to whether *letpet* tea is made from **Camellia theifera** or from rhododendron, by inadvertence doubtless, misrepresents my position at the date of Mr. Bruce's second report. It will be

CAMELLIA theifera.

Review of Recent Correspondence

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as the Government Reporter on Economic Products still seems to have doubts as to whether pickled tea (*letpet*) is made from the tea-plant (C. theifera) or from rhododendron, I am, as requested in your endorsement No. 214—5 G.-1, dated Mandalay, the 14th May 1895, on Revenue Secretary to the Chief Commissioner's letter, taking steps to have complete botanical specimens sent you. I return the enclosure as I understand how to prepare botanical specimens.

5. I quote an extract from my diary written when in the Banmauk subdivision:—

April, 17th.— * * * "All the villages round Kyundaw (Gannan) grow tea in '*kins*' round their villages. This fact is known already as I am aware of. However, I found that though the bushes gave plenty of seed there was no trade in it. Might not the Forest Department buy the seed and sell it to Chindwin traders or elsewhere? This would benefit the villagers considerably." Therefore it would be a good thing if traders would go over and trade in the seed, but of course one could not force the villagers to sell though I am sure they would be only too glad to do so if any one offered to buy.

Wild Tea Seed. *Conf. with pp. 5, 93.*

6. From the above it will be seen that even if tea is wild (which I am sure it is not) in the forests, it is so very rare that any idea of collecting wild tea seed is ridiculous.

From J. W. Oliver, Esq., *Conservator of Forests, Eastern Circle, to the Revenue Secretary to the Chief Commissioner, Burma,—No. 2029—18 E.-2, dated Camp, the 20th December 1895.*

In continuation of my letter No. 347—18 E.-2, dated the 24th May 1895, I have the honour to submit copies of letters No. 186—21 M., dated

Conf. with p. 5.

seen from the correspondence above that the first samples of the *letpet* tea-plant that came to my office arrived (August 23rd, 1894) in a state of complete decomposition. All that I could definitely make out was that the opinion advanced originally in Mason's *Burma and Its People* that the *letpet* tea-plant was a species of Elæodendron was incorrect. But while writing the chapter on Camellia for Volume II. of the *Dictionary of Economic Products* (so long ago as 1887), I stated my opinion even then that *letpet* tea would be found to be but a special preparation from the leaves of Camellia theifera. On a second consignment of the *letpet* tea-plant reaching my office (Mr. Bruce's samples) the letter quoted above (No. 1006—132, dated 18th August 1895) was addressed to the Revenue Secretary to the Chief Commissioner, Burma. It is obviously by an oversight that Mr. Bruce speaks of Rhododendron for Elæodendron.—*Editor, The Agricultural Ledger, and Reporter on Economic Products.*

Conf. with p. 14.

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the 18th September 1895, and No. 2 C.R., dated the 5th December 1895, from the Deputy Conservator in charge of the Katha Forest Division, in regard to the occurrence of wild tea in the Maingthôn group of hills in the Katha district.

Wild Seed. *Conf. with pp. 5, 22.*

I do not consider it necessary at present to make any rules for the collection of seed as, if a large demand were to spring up, it could be more readily met from cultivated plants than from the wild trees.

From H. Jackson, Esq., *Deputy Conservator of Forests, Katha Division, to the Conservator of Forests, Eastern Circle,—No. 186-91 M., dated the 16th September 1895.*

With reference to your office endorsement No 361—18 E.-2, dated the 27th May 1895, I have the honour to submit the following report.

Quantity of Natural sown Tea Seed available.

On both sides of the Maingthôn hill there is a considerable quantity of natural-sown tea-trees, estimated to be not less than 7,000 trees. It is estimated that about 2,000 baskets of seed could be procured here during the year.

The inhabitants sell the leaves, of which the average annual outturn is estimated at 8,000 viss, chiefly from Thayetkaing, Chaungson, Chaung-bya, Maingthôn, Nwalabo, and Kangaw villages.

A basket of seed costs about R3.

The fruit sets in July and is ripe in November.

The above information is supplied by Forester Maung Po Yin.

From H. Jackson. Esq., *Deputy Conservator of Forests, Katha Division, to the Conservator of Forests, Eastern Circle,—No. 2 C. R., dated the 5th December 1895.*

In reply to your letter asking for further enquiries to be made with reference to the tea-plants on Maingthôn hill, I have the honour to report as follows.

Trees not Cultivated.

From enquiries made there seems to be no reason to believe that the trees referred to in my original report are in any way cultivated. Near the foot of these hills close to Legyin, Gangaw, Kyauktaw, and several other villages in the Wuntho and Banmauk subdivisions tea plantations do exist; these plantations are cultivated and kept by different proprietors or villagers. No use is, however, made of the seed produced in these gardens beyond small sowings to replace dead or old trees. The leaves gathered in these plantations are sold at an average price of 8 annas per viss.

Leaves Collected from Wild Trees. *Conf. with pp. 5, 17, 18, 21.*

The trees, however, referred to in my original report are spread irregularly over the forest either singly or in small clumps; they are of all sizes—from 6 feet in girth downwards. The collection of the leaves is from the younger and smaller trees only and is made by parties of men, who go out for five or six days searching for them. Each man in

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Leaf from Wild Tea. *Conf. with pp. 5, 17, 18, 21.*

this time will collect 10 to 12 viss or half the price of the leaves from the gardens. The collection of these leaves is not a regular industry, but is made from time to time by men who wish to earn a little money and who have nothing else to do. These trees are not held to be owned by any one man or even village, though there are only some three or four villagers sufficiently close to the forests to render the collection profitable.

From J. W. Oliver, Esq., *Conservator of Forests, Eastern Circle, to the Revenue Secretary to the Chief Commissioner, Burma,—No, 354-36 A.-4, dated the 18th May 1896.*

In continuation of my letter No. 2029—18 E., dated the 20th December 1895, I have the honour to submit a copy of letter No. 30—40-2, dated the 23rd April 1896, from Mr. J. O. Murray, Deputy Conservator of Forests, Mu Division, forwarding a report on the Maingthôn hills tea together with samples of the specimens collected. I would suggest that the latter be forwarded to the Superintendent, Royal Botanical Gardens, Calcutta.

Rules for Collection of Wild Seed.

I am still of opinion that it is unnecessary to make rules regarding the collection of wild tea-seed.

From J. O. Murray, Esq., *Deputy Conservator of Forests, Mu Division, to the Conservator of Forests, Eastern Circle,—No. 30-40-2, dated the 23rd April 1896.*

With reference to your letter No. 360—18 E.-2, dated the 27th May 1895, regarding the occurrence of wild tea in the Maingthôn hills, I have the honour to inform you that I have visited the hills and beg to submit my report. The specimens will be sent by train.

Report by J. O. Murray, Esq., *Deputy Conservator of Forests, Mu Division, on the Maingthon Hills Tea.*

The Maingthôn hills lie to the North of Wuntho. The highest peak of the range is about 5,500 feet above sea-level; its latitude is about 24° 10′ and longitude 95° 46′.

From Wuntho I marched up the Daungyo chaung as far as Chaungbya village and then crossed the Kangaw range of hills which form the watershed between the Daungyo and Namma chaungs and encamped at Maingthôn village, which is situated on the bank of the Namma chaung and at the foot of the Maingthôn hills. Two days were spent in examining the hill forests round about Maingthôn village for wild tea-trees. I saw altogether 43 trees and plants, the largest

being 3 feet in girth. This tree forked at about $4\frac{1}{2}$ feet from the ground, the measurement was taken below the fork. The top of the tree and its branches had been cut by the villagers when collecting the leaves for *letpet*. In one instance only I came across a group of four or five small trees; otherwise an isolated tree here and a tree there was found all over the forests visited. The trees were generally found growing in dense evergreen forest. The soil being a reddish loam, this is the prevailing kind of soil in these hills.

LETPET TEA. **Trees found isolated not in Plantations.** **Growing on Red Loam.** *Conf. with pp. 9, 10.*

Tea is found in all the forests round the head-waters of the Namma chaung as well as in the forests at the sources of the Kaba and Tayaw chaungs, both of which take their rise in the Maingthôn hills. The Kaba chaung is a tributary of the Namma, the Tayaw flows into the Nammaw.

The Maingthôn villagers have a tradition that the tea-tree was introduced in the Maingthôn hills by the Chins.

Introduced by the Chins.

2. *Collection of Specimens.*—I only came across four trees in flower; these were growing either in light evergreen forest or in dense *waka* bamboo (**Oxytenanthera albo-ciliata**) forest. Trees growing in dense evergreen do not seem to flower.

No old seed was found. Specimens of the plant have been collected and will be forwarded under a separate cover.

3. *Season and Method of Collecting Leaves.*—From Tagu to Kason (about April to May) when the trees are in flush, men from the villages round about come up to the Maingthôn forests to collect the leaves to make "*letpet*." The method of plucking is to seize the shoot about two or three leaves below the tip, the hand is then drawn along the shoot towards the tip; this action causes the two or three leaves to be broken off from the shoot and the tip to be nipped off. They do not nip the shoot clean off where it is first seized. Great injury is caused to the trees by the present method of collecting leaves. The object of the leaf-collectors is to get as much leaf as possible; they are not particular as to the manner in which the leaves are collected. Consequently branches are broken and torn off the trees, the tops of the trees and the branches are cut and even trees are felled. I only came across one tree which had not been mutilated in this way, the tree was growing in dense *waka* forest, and was 9 inches in girth and 28 feet high. Men who come from villages somewhat distant from the forests encamp out for two or three days

Season and Method of Plucking.

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collecting the leaves. When once the rains set in leaf-collectors leave the forests as leeches become very troublesome.

Leaves thrown into Boiling Water.
Conf. with pp. 3, 6, 11, 30.

4. *Method of Making "Letpet."*—The leaves are first thrown into boiling hot water, they are allowed to remain in the water just a short time till they become soft, they are then taken out and rolled by hand on mats. The leaves are then allowed to cool. The next process is to ram the leaves down tight into the internode of *wabo* bamboo (**Dendrocalamus Hamiltonii**) a wooden ramrod being used for the purpose. A stopper is then made of jack or guava leaves, and the bamboos with the *letpet* are stoppered up. The bamboos are then kept in the shade for a couple of days with the stoppered end downwards, to allow of any water there may be in the *letpet* running off. The bamboos are not filled up quite to the top with *letpet*, in the space thus left ashes mixed with a little water are now filled in. The object of the ashes is to prevent insects getting to the *letpet*. The bamboos are now buried under ground till the *letpet* can be taken for sale; if not buried the *letpet* becomes black and spoilt. The *letpet* to be good should be of a yellowish colour. The *letpet* is carried to market for sale in bamboo baskets of open work (*kyin*) lined with leaves, the tea is taken out of the bamboos, and filled in and pressed down tight into the baskets so as to prevent air getting to the *letpet*.

In Wuntho this *letpet* fetches from 2 annas to 6 annas a viss, according to whether tea is plentiful in the market or not. The men about these parts are very badly off for money, they cannot afford to keep the *letpet*, but have to sell it for what it will fetch. The *letpet* from the Shan hills East of the Irrawaddy sells for double the price of the Maingthôn *letpet*. The villagers are of opinion that this is due to the leaves being steamed by the Shans East of the Irrawaddy, while the men west of the Irrawaddy boil the leaves.

Reason for Steaming the Leaves.

5. *The Reason given for Boiling the Leaves.*—About the year 900 Burmese era (A.D. 1539) there was a petty Chief at Kaba. A village of this name is still in existence; it is situated on one of the tributaries of the Namma chaung, which itself flows into the Mu at Pinlebu. This Kaba Chief wished to pay his respects to the Mogaung Sawbwa, and thought of taking *letpet* as a present, he therefore sent two men to Palaung East of the Irrawaddy to buy *letpet*. A short time after the arrival of the men at Palaung one died of fever, the other married

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and settled down there. The Kaba Chief not being able to get the *letpet* took some Kaba salt instead as a present for the Mogaung Sawbwa. The Kaba Chief on his return from Mogaung sent messengers to recall his man who had settled down at Palaung. The man's Shan wife determined to accompany him to Kaba. As her people traded in *letpet*, she collected some tea-seed and filled it into a bamboo to bring away with her Some of her relations accompanied her part of the way, one of them took her load and was carrying it for her; while so doing he heard something rattle in the bamboo, he looked to see what caused the noise and found tea seed. This seed he took away saying that if the woman started tea gardens in her new home, traders would not go up to Palaung to buy their *letpet*. The woman begged to be allowed to take the seed, and said that if they gave her the seed, she would take an oath that the tea leaves should not be steamed in making *letpet* as is done in Palaung, but that the leaves should be boiled, that if any person steamed leaves calamity might befall him. It is this dread of something befalling them which keeps men on this side from steaming the tea leaves.

The tea seed was given to the woman on condition the leaves were not steamed. The seed was sown at Kaba All the tea-plants cultivated in the villages round about Maingthôn as well as in the Ganan circle (at the sources of the Mu river) are said to be derived from this Kaba tea and not from the Maingthôn wild tea.

Wild Tea Bitter. Conf. with pp. 5, 21, 24.

The process of making *letpet* from the wild and cultivated kinds is the same. The *letpet* from the cultivated plants is somewhat better than that made from the wild tea , it is, however, of less value than the *letpet* from East of the Irrawaddy.

Steaming Process.

6. *Method of Making Letpet East of the Irrawaddy.*—As far as I have been able to ascertain, the Shans East of the Irrawaddy steam the tea leaves, then roll them by hand on mats; after this they allow the leaves to cool and then press them down tightly into a pit lined with planks or bamboo matting; the leaves are then covered over and heavy weights put on top. The pit is not opened till a purchaser turns up to buy the whole pit full. The *letpet* is removed in the well-known bamboo crates.

The different process of manufacture may have something to do with the value of the *letpet*.

LETPET TEA.

7. "*Letpet chauk*" is made by putting the green leaves into a vessel and heating them over a fire just long enough for them to become soft. The leaves are then taken and rolled by hand on mats and are then put out in the sun to dry. Only the very tender leaves are taken for making *letpet chauk*.

8. The men who have planted tea about their villages state that their plants are derived from the Kaba trees and not from the Maingthôn wild trees. I have therefore collected specimens of the cultivated species from Maingthôn, Kyaungon and Mankin villages and forward them to you :—

Age of Tea. *Conf with pp. 9, 10.*

(i) Maingthôn village is at the foot of the Maingthôn hills and is surrounded by forests in which tea is found growing. The trees near the village were first planted some 77 years ago. There is no definite information as to where the seed or seedlings were first obtained, but it is supposed from Kaba. The trees are in the open and are covered with moss and look far from healthy. The trees were nearly all in blossom and appeared to have borne a good seed crop last year.

Shade. *Conf. with p. 10.*

(ii) Kyaungôn is on the Daungyo, about 11 miles above Wuntho. It is not known for certain where the first plants were obtained from nor how long ago the first tree was planted. The trees are growing in the *pongyi kyaung* compound and have been planted in the shade of mango, jack and other trees, the shade is not too dense. The plants look more healthy than the ones near Maingthôn village. The trees were in blossom and last year had evidently borne a good seed crop, as numerous young seedlings were noticed under the trees.

(iii) Mankin village is about 9 miles north-west of Wuntho on the Wuntho-Pinka road. This is the only village I have come across in which tea is cultivated to any extent. The gardens (*kins*) were first started in 1204 Burmese era (A.D. 1843) the plants were brought over from Kaba. There are now 16 gardens, the largest being about 2 acres in extent and has about 200 tea-trees in it.

Red Soil Selected. *Conf. with pp. 9, 25.*

Selection of Area for Garden, etc.—If a man wants to start a tea garden (*kin*) he first selects a spot of evergreen forest with a reddish coloured earth (*myeni*). In this spot the smaller trees and brush-

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wood, etc., are cut away, the larger trees are left for shade. I should mention that all the gardens have been started in old *ponsos*, no virgin forest is to be found anywhere near the Mankin village, consequently the forest trees growing in the areas selected for the gardens are not large. The smaller trees and the undergrowth having been cut away, seedlings of from one to three years old are planted out during the rains, but no system is followed in the planting. If no seedlings are obtainable holes are dug and from four to five seeds are sown in each hole. No nurseries are prepared. Seedlings which have germinated in the gardens are taken up and planted out. During the dry season fires are kept out of the gardens, and during the rains the brushwood weeds, etc., are cut back, the ground is not thoroughly cleared. The gardens I have just visited were overgrown with grass and weeds. Each owner increases his garden yearly by planting out a few seedlings. With the exception of keeping out fire and cutting back the weeds during the rains no further trouble is taken with the gardens. The young plants produce their first crop of leaves in from three to four years. The plucking of leaves commences in Tagu and continues till Wagaung (about April to July). Last year Mankin village turned out from 300 to 400 viss *letpet*; the price obtained was from 4 to 8 annas a viss. Seed is not collected as there is no demand for it. A man from Mingin in the Chindwin came over this year to buy seed. The villagers had only 1½ baskets seed collected; this they sold at the rate of R4 a basket.

One to three year old Seedlings.

Season of Flushing.

In the Ganan circle, at the sources of the Mu, a little tea is collected in nearly every village. From Ganan the Mingin agent was able to obtain some 200 baskets of seed at the rate of R4 a basket.

From the Revenue Secretary to the Chief Commissioner, Burma, to the Reporter on Economic Products to the Government of India,—No. 195—5 A.-6, dated the 6th June 1896.

In continuation of the correspondence ending with your letter No. 162—132, dated the 27th January 1896, I am directed to forward 10 copies of an extract from the diary of Mr. W. G. Wooster, on special duty, for the week ending the 28th April 1896, regarding *letpet* tea.

Diary of Mr. W. G. Wooster, *on special duty, Tawngpeng, for the week ending 28th April 1896.*

* * * * * * *

Tuesday, 28th.—"Marched from Mong Ngaw to Ommason *en route* to Namsan to await orders as to when the post is to be withdrawn

LETPET TEA.

Boiling Leaves in Manufacture of Letpet.

Conf. with pp. 2, 6, 11, 26.

and whether the Superintendent, Northern Shan States, is coming out here or not. I saw some *letpet* being prepared here. The tea leaves are not boiled, as is so generally believed, but merely subjected to steam in a wooden steamer with a perforated bamboo bottom placed over a large cauldron of boiling water for about two minutes, so as just to soften the leaves sufficiently and permit of their being easily rolled with the hands on a mat and afterwards compressed in pits by means of heavy weights in the shape of stones placed on top of a wooden cover that fits into the pit over a layer of plantain-leaves. The steamed leaves are only rolled during the brief space of time the next lot of leaves are steaming. By this method of steaming the leaves are readily compressed so as to weigh a lot and take up little space.

The boiling process is unknown in Tawngpeng. Dry tea is manufactured by drying the steamed and rolled leaves in the sun. The best dry tea is that dried in the sun as soon as possible after being steamed, which is generally the next morning, the steaming taking place, as a rule, in the evening after the pickers have returned from the tea cultivations with their loads of leaves.

The description of the manufactory of *letpet* given in the *Kew Bulletin* lately, so far as it concerns Taung-Baing, is incorrect."*

A correspondent writing from the Shan States lately contributed to the *Rangoon Gazette* the following interesting particulars regarding the folklore of *Letpet* Tea:—"According to a legend told by *Paloungs*, one Min-Yama-dee-Kye-thoo many years ago visited the hill of Loiseng in the Taungbaing State, and discovering that the *Paloungs* had no industry determined to give them something to trade in. He sent for the Taungbaing Sawbwa and gave him three seeds with instructions regarding their culture. Yama-dee-Kye-thoo left one of his *amats* (Tsei-thee-damma-minbala) to teach the *Paloungs* the use of the plant when it had grown from the seeds

* This remark would appear to refer to Mr. W. A. Graham's Report (*p. 6*) or to Mr. C. W. A. Bruce's Report (*p. 11 above*) which were given in the *Kew Bulletin* of January 1896, pages 12 and 15. Mr. J. C. Murray's remarks on this subject (*p. 26 above*) will be found specially interesting. It would appear that the Shans East of the Irrawaddy steam the leaves, while West they boil them (or rather drop them into boiling hot water).—*Ed.*

C. 244-256.

given to the Sawbwa. The seeds were planted on Loiseng hill and a tree grew from them. When the tree fructified the seeds were distributed for cultivation and an industry in tea was started. The *Paloungs* were, however, at a loss what to call the new plant and in consequence of the Sawbwa having put out one hand only for the seeds when receiving them from Yama-dee-Kye-thoo they christened it *Let-tit-pet* (meaning "one hand") which has since become corrupted into *Let-pet*. The original tree is still extant on Loiseng hill. It is sacred to the *Paloungs* who worship it. Loiseng is a peak over 6,000 feet high and crowned with glazed and gilded pagodas with a monastery and a pretty "Wat" in which a huge figure of Gaudama sits in contemplation. At Tabaung annually a fair is held here, but amidst all the festal excitement the old tea-tree is not forgotten and always receives its share of gold leaf and worship. I have had wild tea-trees pointed out to me in the jungles but the *Paloungs* say the plant is not the same as that cultivated by them and from which pickled tea is made."

From W. Parsons, Esq., *Secretary to the Indian Tea Association, to* G. Watt, Esq., M.B., C.M., C.I.E., *etc., Reporter on Economic Products to the Government of India,—No. 2940, dated the 22nd July 1896.*

I have the honour to acknowledge receipt of your letter No. 1931—132 of 27th June, which I regret I have not been able to reply to before.

2. In connection with the first paragraph of your letter I regret to state that I am not able to supply any information from papers in possession of the Association on the subject of *Letpet* Tea. A description of it is given in Volume II of the *Cyclopædia of India*, page 706, a book which is no doubt in your possession, but at the same time I may quote the paragraph:—

"*Letpet* Burm. Pickled tea. It is prepared from **Elæodendron persicum.** The leaves are brought from native Burma, and are kept constantly moist. When to be used they are mixed with a little salt, oil, fried garlic, green ginger, and parched sesamum seeds. *Letpet dhok* are small packets of the pickled tea which form part of every Burman ceremonial and are sent as invitations instead of notes or letters."

3. In reply to paragraphs 2 and 3 of your letter I applied to Mr. J. Buckingham, C.I.E., for information, and I have the pleasure to enclose copy of his letter. The Committee regret that they can add nothing to the information Mr. Buckingham has given.

C. 244-256.

CAMELLIA theifera.

TEA.

Review of Recent Correspondence on Letpet Tea, etc.,

From the Hon'ble J. Buckingham, C.I.E., *Amgoorie Post Office, Assam, to* W. Parsons Esq, *Secretary, Indian Tea Association, Calcutta,—dated 16th July 1896.*

I am in receipt of your letter of the 8th instant, enclosing copy of letter from Dr Watt asking for information regarding extensions in Assam and the Tea Seed used.

Conf. with p. 21.

I can safely say that Mr. Bruce's statement is incorrect. Some Chindwin seed may possibly have come in to Assam under the name of Munipore Tea seed, but I think I am within the mark in saying that certainly under 10 per cent., probably not more than 5 per cent., of the clearances have been opened out in the Assam valley with this seed. In many places there is a prejudice against Munipore tea; the plant is very vigorous, but the quality of the tea is said to be inferior.

I am afraid it is impossible to get statistics as to the amount of Assam indigenous seed annually turned out from seed gardens of the Province.

As to the expansion of tea cultivation and tea seed generally, I would refer Dr. Watt to the Annual Report on Tea culture in Assam printed at the Assam Secretariat office. I have not the Report for 1895, but at page 3 of 1894 Report, the total increase in 1894 over 1893 and the area of mature and immature plants is stated to be 12,171 acres. The following statistics are also given regarding tea seed:—

Imports for the whole Province in 1893, 447 mds. Exports in 1893, 5,186 mds.; in 1894, 4,710 mds.*

* The corresponding figures for 1895 were as follows:—

Total increase in 1895 over 1894 in the area of mature and immature plants, 7,218 acres.

Tea seed imported for the whole province, 920 maunds (43 maunds from Lushai and 877 from Manipur.)

Tea seed exported, 13,327 maunds. Assam is therefore an exporting rather than an importing province for tea seed.—*Editor.*

G. I. C. P. O.—No. 208 R. & A. D.—13-8-96.—2,100.—W. B. G.

C. 244-256.

(Veterinary Series, No. 24.)
Medicinal Products.

THE
AGRICULTURAL LEDGER.

1896—No. 28.

OXEN.

(CATTLE DISEASES.)

[*Dictionary of Economic Products, Vol. V.,* O. 551-94.]

THE CATTLE DISEASES OF MYSORE:

Note by MR. A. KRISTNASAMIENGAR, B.A.

CATTLE DISEASE IN MYSORE.

GRAVITY OF DISEASE CONSIDERED

The wide extent of country over which the contagious diseases of cattle sweep in their irresistible course and the immensity of the loss they occasion, rendering all human effort futile, have given rise to superstitious observances on the part of the people for propitiating the angry gods as the only available means. To estimate in money the annual loss to the country's wealth resulting from cattle destroyed by epidemic diseases, would yield an appalling figure if reliable statistics could be secured. One of the most beneficent measures of Government therefore would be to save the agriculturist from the periodical havoc and distress which inevitably follow from it. Something is now being done by some Agricultural Departments, but nothing so far which can in any way be calculated to seriously grapple with the evil. There is no doubt of the magnitude and difficulty of the undertaking. Considering, however, the serious issues involved, no sacrifice seems too much.

Possible efficacy of native veterinary medicines.

Remedies which skilled natives apply to cure or check the progress of the various descriptions of diseases have not been systematically investigated. They are not in some very few cases to be despised.* Though not scientifically explained, those remedial measures, tried by the experience of ages, may not in some cases be without scientific foundation, and at any rate deserve to be investigated before being discarded. The advantage of a tropical sun and variety of climate existing in Mysore afford conditions favourable to the growth of innumerable herbs and plants believed to possess great medicinal virtues. Some of these are well known, but are unfortunately kept a secret, which nothing could induce the men to divulge for the benefit of the public at large.* A systematic and patient investigation by competent men would not, it is believed, fail to yield results of some value.

The recipés given in the following pages are what are constantly used by the people in treatment of cattle in the Province and have been gathered on

* I consider that they are in the majority of cases fanciful and useless.—*H. T. P.*

local enquiry. For one and the same disease different remedies are applied in different localities; in some instances, where one recipé fails, others are tried.

The quantities given in the recipés are for a dose, unless it is otherwise stated. The doses are only approximate, nor does a little more or less make a difference, the drugs not being in a concentrated form. Raiyats are able to regulate the quantity of the drugs and doses by the experience of the eye.

RINDERPEST (*Doddaroga=Gomariroga*).

This highly contagious and fatal disease attacks great numbers of cattle and sweeps off thousands every year.

Country remedies and treatment.

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Camphor powder ½ tola (*Karpura*); (2) Buttermilk 2 hornfuls (*Majjigé*); mix and give once a day. Continue the treatment for one or two days.

Recipé 2.—Take of—(1) Seed-lobes of Indian liquorice (white seeded var.); 2 (*Biliguluganji byalá*); (2) Dessert plantains 2 (*Rasabáli hannu*). Insert the seed-lobes one into each fruit and give to the animal to be swallowed.

Recipé 3.—Take of—(1) **Ferula fœtida** (Asafœtida) ½ tola (*Ingu*); (2) Goat's milk 2 hornfuls (*Mikayabalu*). Mix well together and give once only. When purging has nearly ceased, cleanse the mouth with tepid water and then feed the animal on the following preparation:—

(1) Boiled green gram 1 seer *m* (*Hesarukalu*); (2) Jaggery 2 seers *w*. (*Bella*); (3) Ginger powder 2 tolas (*Sunti*); (4) Cardamoms powdered 1 tola (*Yalakki*). Crush together well and give; continue for two or three days. The treatment should be adopted in the early stage.

Recipé 4.—Take of—(1) Green leaves of **Dæmia extensa** 1 handful (*Halukuratigé soppu*); (2) Leaves of **Justicia Tranquebariensis** ? ½ handful (*Holeraganda soppu*); (3) Underground stem of dessert plantain 2 handfuls (*Rasabalé gaddé*); (4) Onions 24 tolas (*Neerulli*); (5) Roots of **Dregea volubilis** 6 tolas (*Kaduraliyabéru*); (6) Round fruit of **Acacia concinna** powdered 2 tolas (*Gantu sagékayi*); (7) Turmeric powder 1½ tolas (*Arasinapudi*); (8) Buttermilk or *conji* sufficient quantity (*Majjigé or Conji*). Crush the first five together adding the last, then express the liquid portion, mix (6) and (7) and give twice a day.

Recipé 5.—Take of—(1) Infusion of fresh bark of '*jamoon*' (*Jambunerlé chakkékeshaya*); (2) '*Ragi*' flour ½ seer *m*. (*Ragihittu*); (3) Dessert plantains 6 (*Rasabalé hannu*); (4) Juice of **Canna indica** leaves $\frac{1}{16}$ of a seer *m*. (*Maragadi soppinarasa*). Prepare '*ragi*' *conji* using infusion No. (1) instead of water, then add (3) and (4) to 4 hornfuls of *conji* and give as a drench; twice a day, for three days. Wash the mouth with old tamarind and tepid water, previous to giving the drench.

Recipé 6.—*First day.*—Take of—(1) Honey-combed gray matter found in white-ant-hills 12 tolas (*Huthadaguggi*); (2) Buttermilk 2 hornfuls (*Majjigé*). Mix and give; twice a day.

Second day.—Take of—(1) "*Samé*" *conji* 2 hornfuls (made of flour of fried grain of **Panicum frumentaceum**) *Samé, Okkaganjee*; (2) Juice of '*jamoon*' bark ½ hornful (*Gembu nérlachakkérasa*); (3) Juice of panicled **Acacia** bark ½ hornful (*Billijali chakkeye rasa*); (4) Juice of **Acacia ferruginea** bark ½ hornful

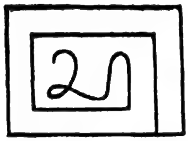
RINDERPEST.

Country remedies and treatment.

Bannichakh rasa ; (5) Juice of "Gandu Yasaga" leaves ½ hornful (*Ganduyasagalé soppina rasa*) ; (6) Juice of leaves of **Justicia Tranquebariensis** (?) ½ hornful (*Holéra ganda soppu*). Mix and give ; twice a day.

Third day.—Take of—(1) Juice of the underground stem of dessert plantain ½ hornful (*Bali gaddé rasa*) ; (2) Juice of **Asparagus racemosus** ½ hornful (*Majjigé gaddé rasa*) ; (3) '*Ragi*' *conji* 3 hornfuls (*Ragi ambali*). Mix and give ; twice a day.

On the first or second day of the treatment the animal is marked on the left flank in the following form, using fresh slaked lime instead of hot iron :—



The mouth is frequently washed with tepid water and old tamarind and fumigated by burning sulphur. Sanitary points are carefully attended to, and the animal is fed on '*ragi*' *conji*. If it is not fully restored to health, the whole process may be repeated again, diminishing the doses by ¼ or ½.

Recipé 7.—Take of—(1) Tiger or cheeta flesh, dry, 6 tolas (*Huliya Athava chiratheya mamsa*); (2) Cold water 2 hornfuls (*Thannuru*). Grind together and give every morning ; and continue for three days. Wash the mouth of the animal with tepid water and maintain its strength on '*ragi*' *conji*.

Tiger or cheeta flesh is preserved in pots, in thin slices, well dried, care being taken to prevent decay.

Recipé 8.—Take of—(1) Cheeta or tiger flesh, dry, 6 tolas (*Huliya Athava chiratheya mamsa*); (2) **Ferula fœtida** (Asafœtida) ½ tola (*Ingu*); (3) Water in which rice has been washed 2 hornfuls (*Akkitholada neeru*). Roast (1) and (2) partially, triturate them together and mix in (3) and give the mixture ; repeat this twice a day for two or three days.

Recipé 9.—Take of—(1) **Justicia Tranquebariensis** (?) leaves 6 tolas (*Holeraganda soppu*) ; (2) Either fat or flesh of tiger 6 tolas (*Hulimamsa ya Kobbu*) ; (3) Toddy 2 hornfuls (*Henda*). Grind the first two together, mix with toddy and give it to drink ; twice a day, for two days ; and feed the animal on the following preparation :—(1) Dessert plantains 10 (*Rasabalé hannu*) ; (2) Sugarcandy 6 tolas (*Kallusakkaray*) ; (3) Fenugreek (**Trigonella Fœnum-græcum**) powder 6 tolas (*Menthya*); (4) Rice *conji* 6 hornfuls (*Akkiganji*) (rice of boiled paddy not used). Mix and give; repeat twice a day. More may be given if necessary, and at any time, to maintain the strength of the animal.

Recipé 10.—Take of—(1) Fruit of cooking plantain 2 (*Kathé balé hannu*; (2) *Gingelly oil* (**Sesamum indicum**) $\frac{1}{16}$ seer *m*, (*Ollé yellu yenné*); (3) Chebulic myrobalans powdered 2 tolas (*Alalé kayé*) ; (4) Sulphur $\frac{1}{16}$ tola (*Gandhaka*). Mix and give ; twice a day, and continue for three days.

Recipé 11.—Take of—(1) Flesh from the thigh of an animal of the same species that died from this disease 2 seers *w*. (*Boddare-*

FOOT AND MOUTH DISEASE.

gadinda Sathadanda thodaya mamsa); (2) Borax powdered 1 tola (*Surattri-Baligara*); (3) **Curcuma sp.** powdered 2 tolas' (*Kasthuri Arasina*). Coat the flesh with the powder, boil it in water and give 3 hornfuls of that water once. This is a preventive. The powder coating, besides its own therapeutic action, is said to preserve the flesh from decay when it is to be kept for a time.

Recipé 12.—Take of—(1) Dessert plantains 20 (*Rasabalé hannu*; (2) *Ghi* ⅛ of a seer *m.* (*Thuppa*); (3) Camphor powder ⅛ tola (*Karpura*). Mix and give once only.

Country remedies and treatment.

FOOT AND MOUTH DISEASE (*Kalujvara Bayijirara—Ghali shakhé*).

This contagious but rarely fatal disease spreads over large tracts attacking great numbers at a time. It prevails generally in the hot season.

Native Treatment.—The diseased animal is fed on nutritious food. In the early stage it is made to stand in mire or water for some hours every day; and later, tar, or camphor and **Pongamia glabra** oil mixed, or '*nim*' oil, is applied to the sore foot to prevent maggots from forming. The sore heals in the natural course. When the disease appears in the locality, all the healthy animals are treated, as a preventive measure, in the following manner :—

Take—Cooking plantains, rather overripe (*Kathé baléya-kalitha hannu*), (2) Gingelly oil a sufficient quantity (*Ollé yellu yenné*). Dip one-fourth part of the fruit in the oil and give it to be swallowed.

Secure water in which fish has been washed, and wash the mouth and feet of the diseased animal with it, giving at the same time a hornful of it as a drench. Feed the sick on pure insipid *conji* of either rice or '*ragi*.' To bathe the mouth and feet of healthy animals with water containing the washings of fish and to sprinkle it in and about the cattle yard is believed to prevent or mitigate the disease. The operation may be repeated if necessary.

SPLENIC APOPLEXY.

* SPLENIC APOPLEXY (*Naradi—Sukhanaradi—Doddanaradi*).

This is reported to be a very frequent and rapidly fatal disease, mostly affecting animals in high condition. Feeding on ground-nut oil-cake, without salt, is said to predispose an animal to this disease.

Native Treatment.—*Recipé* 1.—Take of—(1) Dry ginger, powdered, 2 tolas (*Sunti*); (2) Long pepper, powdered, 2 tolas (*Hippali*); (3) Black pepper, powdered, 2 tolas (*Menasu*); (4) Indian liquorice (white seeds), powdered, 1 tola (*Thanneeru*); (5) Cold water 3 hornfuls (*Billgulaganji*). Mix and give as a drench.

Recipé 2.—Take of—Dry chillies, ground, 6 tolas (*Onamenasinakayé*), (2) Buttermilk, 3 hornfuls. Mix and give.

Recipé 3.—Take of—(1) Dry ginger, powdered, 1 tola (*Sunti*); (2) Dry chillies, powdered, 1 tola (*Menasinakayé*); (3) Black pepper powdered, 1 tola (*Menasu*); (4) Garlic 2 tolas (*Belluili*); (5) Leaves of **Anisomeles ovata** 1 handful (*Hoddunobé soppu*); (6) Leaves of **Leucas zeylanica** 1 handful (*Thumbé soppu*); (7) Bark of horse radish 4 tolas (*Nuggechakké*); (8) Bark of **Capparis zeylanica** 4 tolas (*Thotlichakké*); (9) Bark of **Cordia sp.** 2 tolas (*Thapasichakké*); (10) Tepid water 4 hornfuls. Crush the

* Occurrence doubtful.—*H. T. P.*

SPLENIC APOPLEXY.

Country remedies and treatment.

barks and leaves well, then add the other ingredients and give the mixture as a drench; once only. This is also useful in "Chronic Emaciation and Weakness."

Recipé 4.—Take of—(1) **Wrightia tinctoria** leaves 1 handful (*Maréhali soppu*); (2) Black pepper 1 tola (*Menasinakalu*); (3) Garlic cloves ½ tola (*Bellulli hilaku*); (4) Buttermilk 3 hornfuls (*Majjigé*). Grind the first three together, mix with buttermilk, and give.

Recipé 5.—Take of—(1) Bark of **Albizzia Lebbek** 4 tolas (*Bagimarad chekké*); (2) Leaves of **Toddalia aculeata** 4 tolas (*Kadu menasigé soppu*); (3) Leaves of **Azima tetracantha** 4 tolas (*Bili vuppé soppu*); (4) Black pepper 2 tolas (*Menasu*); (5) Garlic 1 tola (*Bellulli*). Pound all these well together, add tepid water and give 3 hornfuls. Apply hot water to the region of the spleen, using a wet cloth to confine the liquid to the part. Grind finely the seeds of elephant creeper (*Samudrapalabeeja*) with water and touch the eye-balls with the mixture so prepared.

In some taluks of the Province where cattle-breeding is largely carried on, some experts drive a small nail or thin peg, generally of the wood of **Dodonæa viscosa**, through the intercostal muscles, on the left side, on the region of the spleen; the peg is then withdrawn and a small quantity of hot oil poured through a tube inserted into the hole so as to just touch the swollen spleen. The heat imparted is said to afford a quick relief, the spleen contracting almost immediately; but this is a dangerous operation in the hands of inexperienced men.

Recipé 6.—Branding on and about the region of the spleen in various fashions, or in dots running up and down, is sometimes resorted to.

Recipé 7.—Recipé No. 7, under "Chronic Emaciation and Weakness" is also considered a useful remedy for this.

NOTE.—In cases of "Splenic Apoplexy" cold water and green fodder is given for four or five days even after relief.

CHARBON SYMPTOMATIQUE, OR BLACK QUARTER.

(*Chappé jadya*).

CHARBON SYMPTOMATIQUE.

This is another fatal disease which runs its course within a short time. It is said to have appeared in the Province within the last twenty years. Till recently, only young animals of five years and below, and in high condition, were found to be affected, but in the south-east of the Province animals of all ages have been lately attacked, young ones, however, forming by far the great majority of the victims.

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Dessert plantain flower (minus the leathery sheath) 24 tolas (*Balé hoovinolaginakusuma*); (2) Cummin (**Nigella sativa**) seed 2 tolas (*Jeerigé*); (3) Onions 24 tolas (*Neerulli*); (4) Aerial roots of screwpine 24 tolas (*Kéthaki gaddé beelu*); (5) Buttermilk or sour *conji* 3 hornfuls (*Hulimajjigé ya Hulgonji*). Grind the first four together, mix with buttermilk or *conji*, and give once a day; continue for three days.

Recipé 2.—In the affected part patches of blackened blood are found which crackle on pressure. Rub the part briskly till it feels-

OXEN.	Cattle Diseases of

CHARBON SYMPTOMATIQUE.

soft, and apply a ring of heated iron and burn well in triangular dots, thus :—

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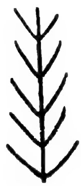
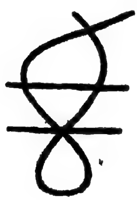
Country remedies and treatment.

Recipé 3.—Take of—(1) Expressed juice of **Vitis quadrangularis** ⅛ seer *m.* (*Mangaravalli rasa*) ; (2) Expressed juice of American aloe ⅛ seer *m.* (*Kathalipatté rasa*) ; (3) Mustard powder 4 tolas (*Sasuré*) ; (4) '*Ragi*' flour 4 tolas (*Ragi hittu*) ; (5) Cow's urine ¼ seer *m.* (*Hasudina ganjala*). Mix and boil and apply to the swollen thigh while hot and warm it well. Several coats may be applied.

Recipé 4.—Brand the entire surface of the swollen part in the following form :—



Recipé 5.—When the disease breaks out, all the healthy and young animals in the locality are branded on the right shoulder and the left thigh as a preventive measure, the prominent projections of shoulder and pelvic bones being inclosed within the figure—



Recipé. 6—Take of—(1) Fresh leaves of mature tanner's cassia 2 handfuls (*Hali avarike gidada balitten soppu*) ; (2) Lard ¼ seer *m.* (*Handi thuppa*) ; (3) Lizards 2 (Lacertata sp.—*Havarani*). Grind the leaves finely, mix with the lard in a pot, and heat the mixture to boiling, then throwing the lizards into it and continuing boiling till they get digested. The mixture thus got is preserved in pots and 2 tolas of it is given with a hornful of tepid water to the affected animal.

O. 551·94.

Mysore. (*A. Kristnasamiengar.*) **OXEN.**

PLEURO-PNEUMONIA.

ORDINARY PLEURO-PNEUMONIA (*Dommí jadya*).

This disease is not so common in this country as some of the diseases above described, though when it makes its appearance it generally proves fatal. It does not attack great numbers, and it is not contagious. The effects of the disease are sometimes slow and sometimes very rapid; both the lungs and the pleura are affected.

Country remedies and treatment.

Native Treatment.—*Recipé* 1—Take of—(1) **Evolvulus alsinoides** plants 1 handful (*Vishnukranthi*); (2) Roots of Indan birthwort 1 handful (*Esvaribéru*); (3) Leaves of **Solanum nigrum** (red fruit variety) 1 handful (*Kumpukachi soppu*); (4) Leaves of **Physalis peruviana** 1 handful (*Seeguppatti soppu*); (5) Leaves of **Andrographis serpyllifolia** 1 handful (*Saradalyalé*); (6) Leaves of **Ocimum sanctum** (var. lemon-scented **Ocimum**= *Nimbathubasi soppu;* (7), Leaves of **Bryonia sp.** 1 handful (*Surasurake soppu*); (8) Leaves of **Cephalandra indica** 1 handful (*Seethonde soppu*). Crush and express the juice of all these together and give it as a drench, one hornful; twice a day for three days.

Recipé 2.—Take of—(1) Black pepper, powdered, 4 tolas (*Menasu*); (2) *Ghi* ½ seer *m.* (*Thuppa*). Mix and give.

Brand the animal on the region of the lungs in dots in the following form— ° ° ° or, boil a mixture of buffalo dung and water and pour on this region confining it to the spot for a short time.

Recipé 3.—Recipé 7 under "Chronic Emaciation and Weakness" supplemented by two cypher brandings, one on each side on the region of the lungs, is said to be a useful remedy for this, as also recipé No. 8 under the same disease.

Recipé 4.—Brand with hot iron commencing from the middle of the breast, and continue backwards through the region of the lungs on both the sides up to the "*Suli*" or hair mark on the back commonly called "cowlick."

Keep the sick animal well housed in a warm but well-ventilated place.

INFLAMMATION OF INTESTINES

Inflammation of intestines.

(*Údanaradu=Karalubyané Karalubbara mathu neru*).

Native Treatment.—*Recipé* 1.—Take of—(1) Castor oil ½ seer *m.* (*Haralenné*); (2) Decoction of ginger and black pepper (2 tolas each), ½ seer *m.* (*Sunti mattsamenasina kashaya*); (3) **Ferula fœtida** (Asafœtida) ½ tola, mix and give. Keep repeating this dose from three to four times a day notwithstanding the other remedies that may be adopted; and frequently foment the belly with a hot "*cumbly.*"

Recipé 2.—Recipé 3 under 'Splenic Apoplexy' is a useful remedy when resorted to in the early stage of this disease.

Recipé 3.—Take of—(1) Mustard powder 4 tolas (*Sasuvé*); (2) White onions pounded 12 tolas (*Bili Neerulli*); (3) Turmeric powder 1 tola (*Arsina*); (4) Leaves of **Achyranthes aspera** pounded 1 handful (*Utharané soppu*). Mix these well in water and give 3 hornfuls, once.

APHRO-DISIACS.

Recipé 4.—Apply hot iron in the form of a small cypher, one on each flank.

Note.—In inflammatory disorder of lungs, spleen, bowels and quarters, hot fomentations are applied to the region of the inflamed organ besides cauterizing with various designs. Some persons, instead of branding with hot iron, impart heat to the part by boiling oil or water, or a mixture of cow-dung and water, also boiling. The heat is applied in definite points, the liquid being confined to those points.

APHRODISIACS GIVEN TO COWS. (*Adari Owshadha.*)

Some cows though not sterile are in too good a condition and do not manifest an inclination to take bulls.

Recipé 1.—Take of—(1) Aerial roots of fragrant screw-pine 6 tolas (*Kéthaki gaddi beelu*); (2) Sheep's ghee 4 tolas (*Kurithuppa*); (3) Cow's ghee 4 tolas (*Hasuvinathuppa*); (4) Goat's ghee 4 tolas (*Mékéthuppa*); (5) Honey 4 tolas (*Jénuthuppa*). Grind the roots to a fine paste, mix with other ingredients and apply to the vagina, once a day. It should be repeated for several days.

Recipé 2.—Take of—(1) Spawns of fish with the cellular matter enclosing them 4 tolas (*Meenina motté mathugédu,*); (2) Cow's milk 2 hornfuls (*Hasuvinahalu*). Grind the first with milk and give once a day; continue for four or five days.

Recipé 3.—Give 6 or 7 young fish finely ground and mixed with water once a day, and continue for four or five days.

ABORTION.

Causes and country treatment.

ABORTION OR MISCARRIAGE. (*Kanduhakuvadu.*)

Cows abort from injuries, from the presence in the system of serious blood diseases and from various other causes, internal and external.

In all cases of apprehended abortion the treatment is adopted very early lest it should be too late.

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Leaves of **Lactuca Heyneana** 4 tolas (*Haluhakkiruké Soppu*); (2) Stem and leaves of humble plant 4 tolas (*Muttidaré muniya*); (3) Red chalk 2 tolas (*Yajnkallu*); (4) Cold water 2 hornfuls (*Thanneeru*). Crush the first three finely, mix in water, and give once a day; and continue for three days.

The above mixture is also given with, it is said, advantage when it is suspected that the impregnated ovum is likely to be discharged, within the first month of pregnancy. It is said to remove the tendency to abort when given for three or four days immediately after conception.

This is also prescribed when milch cows pass milky-white urine.

Recipé 2.—Take of—(1) Underground stem of the lotus 1 handful (*Thavaré gerusu*); (2) **Amarantus mangostanus** plants 2 handfuls (*Kirhasalé soppu*); (3) Tender citrons 2 (*Madalada Heechu*); (4) Roots of **Ficus Tsiela** 2 handfuls (*Bilibasaribéru*); (5) **Dolichos Lablab** 1 handful (*Avareya Arinéraloo*); (6) Buttermilk 5 hornfuls (*Majjigé*). Grind all the first five together, mix with buttermilk and give when abortion is threatened, and continue for two or three days.

Keep the animal segregated and in perfect rest and keep the loins and haunches covered with a cloth dipped in cold water, the fluid being wrung out.

Mysore. (*A. Kristnasamiengar.*) **OXEN.**

RED MILK. (*Raktha kariyuvadu.*)

RED MILK.

Country remedies.

Recipé 1.—Take of—(1) Seeds of henna shrub powdered 1 tola (*Madhurangi buja*); (2) European frankincense pulverised ½ tola (*Kavadé Sambrance*). Mix, throw on a slow fire and fumigate the udder. Sometimes only frankincense (either European or common or a mixture of both) is used without henna seeds.

Recipé 2.—Take of—(1) Roots of shoe-flower plant (white flowering variety) 2 handfuls (*Bilidasavaladabéru*); (2) Sour buttermilk 4 horn fuls (*Hulimajjigé*). Grind the roots well, mix with buttermilk and give twice a day for three days.

Recipé 3.—Take of—(1) Cardamoms powdered ½ tola (*Yalakki*); (2) Juice of the leaves of Herpestris Monniera $\frac{1}{16}$ seer *m.* (*Neerubamu Soppu*); (3) Dessert plantains 5 (*Rasaba likanna*); (4) Curds ½ seer *m.* (*Mosaru*). Mix all together and give; twice a day for three days. This is also prescribed in 'Hæmaturia.'

HÆMATURIA, BLOODY URINE OR BLACK URINE.

HÆMATURIA.

(*Rakthaganjala—Rakthapinjori. Madigapinjari.*)

This is a disease common during the hot season when food and drink are poor and scanty.

Symptoms.—General febrile symptoms are present with frequent passage of a small quantity of urine, attended with pain, straining and prostration of strength. The urine is colored red (blackish red or even black later on (=*Madigapinjari*), and mixed with blood. Diarrhœa may be present, followed by costiveness. The coat stares, the skin is dry, and the animal looks dull. It does not feed or ruminate, breathing becomes hurried, and emaciation is rapid. The animal dies of exhaustion in a few weeks.

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) '*Ragi*' flour ½ seer *m.* (*Ragibitter*); (2) Fenugreek (Trigonella Fœnum-græcum) 6 tolas (*Menthya*); (3) Cold water a sufficient quantity (*Thanneeru*). Soak the fenugreek in water and grind it well. Prepare '*ragi*' *conji*, mix the ground fenugreek and put by for twelve hours. The mixture, when stale, is given 4 hornfuls; and repeated twice a day for three days.

Recipé 2.—Take of—(1) Fresh bark of panicled Acacia 24 tolas (*Bilijali chakké*); (2) Buttermilk 3 hornfuls (*Majjigé*). Grind the bark finely, mix with buttermilk, strain and give the liquid as a drink; twice a day for three or four days.

Discontinue all heating food such as oil-cakes, paddy straw, horse-gram, etc.

Recipé 3.—Take of—(1) Onions crushed finely 24 tolas (*Neerulli*); (2) '*Ragi*' flour ½ seer *m.* (*Ragihittu*); (3) Cold water 5 hornfuls (*Thanneeru*). Prepare '*ragi*' *conji*, mix the onions ground and give the mixture to drink; repeat this twice a day for three or four days.

Recipé 4.—Take of—(1) Pigeon pea ½ seer *m.* (*Thogarikalu*); (2) Fresh bark of Tanner's Cassia, Cassia auriculata, 24 tolas (*Thangadichakké*); (3) Buttermilk 4 hornfuls (*Majjigé*). Soak the pigeon pea in water for two or three hours, grind it finely together with the Cassia bark, add buttermilk, stir and give as a drench, twice a day; continue for two or three days.

HÆMATURIA.

Recipé 5.—Take of—(1) Rice (ordinary) ¼ seer *m.* (*Belathakki*); (2) Curds 5 hornfuls (*Mosaru*). Prepare rice *conji*, using water, and keep both *conji* and curd exposed to dew during the night; early in the morning just before sunrise mix them in the proportion of one of curd to two of *conji* and give 6 hornfuls of the mixture to drink, repeating the dose two or three mornings. (The above is also given in Dysentery.)

Recipé 6.—Take of—(1) Onions (white variety) 12 tolas (*Bilinceruḷḷi*); (2) Bulbs of Crinum species 12 tolas (*Kadu neeru li*); (3) "*Ginimooti gaddé*" 12 tolas (*Ginimoothi gadde*); (4) Sour buttermilk 4 hornfuls (*Huḷimajjigé*). Grind (1), (2) and (3) together, add buttermilk, strain, and give 3 hornfuls of the mixture to drink, repeating the dose again if necessary.

Recipé 7.—Take of—(1) Fresh leaves of **Andrographis serpyllifolia** 6 tolas (*Saradaḷivelai*); (2) Onions (white variety) 10 tolas (*Bilinerrulli*); (3) Zedoary pulverised 2 tolas (*Kasthurri arasina*); (4) *Ghi* a sufficient quantity (*Thuppa*). Pound the first three together finely (using no water), add *ghi* and roast the mass in a pot, give the mixture so prepared in the morning either as a drink with more *ghi* or as a ball; once only.

For the evening.—Take of—(1) "*Samé*" rice (prepared from boiled grain of **Panicum frumentaceum**) ¼ seer *m.*; (2) Buttermilk (buffalo's for a cow, and *vice versâ*) 6 hornfuls (*Majjigé*). Boil the rice with water, add buttermilk when cool, mix and give.

This is also said to be useful for Hæmaturia combined with diarrhœa or dysentery in which the stools are offensive.

Conf. p. 9.

Recipé 8.—Recipé 3 under "Red Milk" is also used.

Recipé 9.—Take of—(1) Fresh bark of **Jatropha Curcas** a sufficient quantity (*Huchakaralu chakké*); (2) Pulverised areca nut 2 tolas (*Adiképudi*). Crush and express the juice of the bark, mix areca nut powder and give a hornful of the mixture.

Recipé 10.—Take of—(1) Bark of white flowering **Bauhinia purpurea** or of panicled Acacia 2 handfuls (*Bilikanchuvalada chakke* or *Bili jali-chakké*); (2) Buttermilk a sufficient quantity (*Majjigé*). Crush the bark finely, macerate in buttermilk, mix and decant the liquid; next warm this liquid slightly by dropping into it a few pieces of heated quartz, and give 3 hornfuls of it as a drench, repeating the dose once more if necessary.

This is also useful in Diarrhœa and in Dysentery.

CHOKING.

CHOKING. (*Ganttu laḷa dalli thadé—Gantta sokku.*)

Cattle sometimes choke while feeding too greedily, especially on oil cakes and stalks of '*cholum*' and '*ragi*' not properly crushed. The latter are swallowed greedily at certain stages of their growth on account of their peculiar relish. Hair balls, fibrous plants and hard substances also when swallowed often get stuck up in the gullet.

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Fruit or leaves of **Hibiscus esculentus** 2 or 3 handfuls (*Bendé kaye athava Soppu*); (2) Cold water 3 hornfuls. Grind the leaves finely, using water, strain the mixture and pour a small quantity down the gullet, four or five times, in the early stage.

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CHOKING.

Recipé 2.—Break 4 or 5 eggs and pour the liquid contents down the gullet of the animal in the early stage.

Country remedies and treatment.

Recipé 3.—Examine the gullet by introducing the hand, and gently pull out the obstructing material if it can be reached; the mouth during the operation being kept open by introducing into it a thin round piece of wood perforated in the middle, to insert the hand. If the obstruction is farther off, secure a succulent and fairly flexible stem of either **Calotropis gigantea** (*Yekkadakaddi*) or **Jatropha Curcas** (*Huchaharalu kaddi*) sufficiently long and free from knots, apply castor oil to it and introduce slowly into the gullet so as to reach the stomach; any obstruction in the passage is thus thrust into the stomach, the stick being then withdrawn.

Recipé 4.—Take of—(1) **Wrightia tinctoria** leaves 1 tola (*Marahali soppu*); (2) Black pepper ½ tola (*Menasu*); (3) Garlic cloves 5 (*Bellulli kilaku*). Chew all these together and having the mass in the mouth blow forcibly for ten or twelve minutes into the mouth of the animal, keeping it open by introducing a circular board with a hole in the centre, while its ears and nostrils remain partially shut.

Recipé 5.—Take of—(1) Elephant's dung 12 tolas (*Anéladdi*); (2) Underground portion of edible mushrooms 6 tolas (*Thimuwa anabé béru*); (3) The flower of fragrant screw-pine (without the petals) 12 tolas (*Kétteaki huvvina laddu*); (4) Tamarind pulp 12 tolas (*Hunasé hannu*). Grind these together finely, adding a sufficient quantity of water, express the liquid and give a hornful of it, immediately followed by an equal quantity of a saturated solution of lime water.

Recipé 6.—Mix the dung of the affected animal with water so as to make a thick mixture and pour 3 hornfuls down the gullet in the early stage.

Recipés 1, 2 and 3 are intended to remove obstruction in the gullet while 4, 5 and 6 tend to reduce the attendant tympany.

TYMPANITES OR HOVEN. (*Hotté-novu-Hotté vootha.*)

TYMPANITES.

This is a very common disorder among cattle of this country and prevails in the season when green fodder springs up following the hot weather. It is caused by too free a use of succulent food, or overfeeding without due mastication. Half-starved cattle often get into cultivated fields and gorge themselves on growing crops of which *cholum* (before flowering and especially the fresh shoots of a ratoon crop) is said to be the most frequent cause of the malady. Mature dry pods of panicled Acacia and leaves of castor oil plant are also injurious and cause mortality.

Native Treatment.—*Recipé* 1.—Take of—(1) seeds of *Jamoon* 6 tolas (*Nayinéralébeeja*). Pulverise the seeds, mix with tepid water and give 3 hornfuls.

Recipé 2.—Make the animal chew a few succulent stalks of either **Calotropis gigantea** (*Yekkeedakaddi*) or **Jatropha Curcas** (*Huchaharalu kaddi*) or **Pedilanthus tithymaloides** (*Seemé kalli*). If it is unable to chew, grind the bark of **Jatropha Curcas** 2 seers w. in 2 hornfuls of water, strain and give as a drench.

TYMPANITES (CHRONIC).

TYMPANITES (CHRONIC).

This form of Tympanites is also common and arises from a want of tone in the stomach and consequent impaired digestion. Gas is generated in the stomach, which appears partially inflated, often subsiding about midday and again bloating towards the evening or night. The animal does not feed well and looks sickly.

Country remedies and treatment.

Recipé 3.—Take of—(1) Roots and stem of **Andropogon Schœnanthus** 2 handfuls (*Kachi ganté*); (2) Roots and stem of **Aristida cœrulescens** 2 handfuls (*Parikéhauchiganté*); (3) Bark of **Capparis zeylanica** 2 handfuls (*Thollichakké*); (4) Jaggery 24 tolas (*Kattegé kabbuia ya chénikabbina bella*). Grind all these together finely, mix with water, strain the mixture, and give 2 hornfuls a day for two or three days.

Recipé 4.—Take of—(1) Greater galangal 3 tolas (*Dumparasmé*); (2) Black pepper 3 tolas (*Menasu*); (3) Omum seed 3 tolas (*Omu*); (4) Sweet-flag 2 tolas (*Bajé*); (5) Ginger 3 tolas (*Sunti*); (6) Cloves 2 tolas (*Lavanga*); (7) Common salt 6 tolas (*Uppie*); (8) Coriander seed 12 tolas (*Kothumbari buja*); (9) **Chebulic Myrobalans** (cortex) 4 tolas (*Alalékayihottu*); (10) Chillies 4 tolas (*Menasinakayi*); (11) Round fruit of **Acacia concinna** 6 tolas (*Gantuseegékayi*); (12) Mustard 4 tolas (*Sasuvé*). Pound them all together, soak in a pot containing 4 seers *m.* of water for a few hours, boil the mixture to reduce the liquid to ½ seer, strain and give as a drench once a day, and continue for three or four days

Recipé 5.—Brand both the flanks in triangular lines.

FARDEL BOUND.

FARDEL BOUND. (*Nárondu Pottéyemba hottínovu = Hotté kottu Jadya.*)

Cases of this disorder mostly occur in the hot season when animals from scarcity of good forage, take to feeding on coarse, dry, indigestible stuffs which are woody, corky or fibrous, such as leaves of **Agave americana** (*Bhuttále, budukattale naru*), dry blades of sugarcane leaves, certain fibrous grasses, and the common thatching material of houses.

NATIVE TREATMENT.—*Recipé* 1.—Recipé 3 under Inflammation of Intestines is said to be a useful remedy for this disorder when accompanied by liberal doses of castor oil or **Magnesium sulphate**; '*canji*' mixed with small quantities of pulverised ginger and black pepper is the best food to give during treatment.

DIARRHŒA.

DIARRHŒA. (*Bhédi-Amabhédi.*)

Diarrhœa may be symptomatic of other more serious disorders which are noticed elsewhere. In its idiopathic form it is very common attacking debilitated animals in the early rains when fresh grass springs up. It prevails also in other seasons due to sudden changes of food and weather; nor is it altogether rare in the hot season owing to unwholesome food and impure water to which cattle have then to resort.

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) *Jamoon* bark (fresh) 2 handfuls (*Jambunérali chakké*); (2) Bark of panicled Acacia 2 handfuls (*Bilijali chakké*); (3) Bark of Tanner's Cassia 2 handfuls (*Thangadi chakké*); (4) Red chalk 2 tolas (*Jajukallu*); (5) Buttermilk 4 hornfuls (*Majjigé*). Crush the first four together finely, mix with buttermilk, strain the mixture and give it as a drench; repeat this twice a day for two or three days.

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Recipé 2.—Take of—(1) Fenugreek (**Trigonella Fœnum-græcum**) 6 tolas (*Menthya*); (2) Leaves of **Canthium parviflorum** 2 handfuls (*harésoppu*); (3) Buttermilk 4 hornfuls (*Majjigé*). Grind the first two finely, mix with buttermilk and give as a drench; repeat this twice a day for one or two days. **DIARRHŒA.**

Country remedies and treatment.

Recipé 3.—Take of—(1) Expressed juice of leaves of **Dæmia extensa** $\frac{1}{16}$ seer *m.* (*Halukuratijé Soppina rasa*); (2) Buttermilk 3 hornfuls (*Majjigé*). Mix and give twice a day for two or three days.

Diarrhœa of a separate nature often sets in, in which the fæces or urine or both are mixed with blood and smell offensively. This is attributed to swallowing certain insects while feeding. The following recipés are used in such cases:—

Recipé 4.—Take of—(1) Flower-heads of **Andropogon Schœnanthus** 1 handful (*Kachi hurrina thiné*); (2) Soot (Carbon) 2 tolas (*Illana*); (3) The earth of the nest of solitary wasps 3 tolas (*Kanajana gudina mannu*). Crush all these well, add cold water, strain and give 3 hornfuls as a drench.

When the motions become arrested by the above—

Take of—(1) Dessert plantains 5 or 6 (*Rasubalé hannu*); (2) Castor oil $\frac{1}{8}$ of a seer *m.* (*Haralenné*). Mix and give. The ingredients should be mixed just before giving as the mixture soon hardens.

Recipé 5.—Recipé 10 under Hæmaturia is also useful in Diarrhœa. *Conf. p. 10.*

DYSENTERY. (*Rakthabbhédi.*) **DYSENTERY.**

NATIVE TREATMENT.—*Recipé* 1.—Give a hornful of the juice of leaves of **Cephalandra indica** (*Seethondé soppina rasa*), immediately followed by an equal quantity of milk (*Hálu*) with which is mixed a small quantity of finely-ground hæmatite (*Kavikallu*).

Recipé 2.—Take of—(1) Rice of boiled paddy $\frac{1}{4}$ seer *m.* (*Kudup alakki*); (2) Green gram dohl $\frac{1}{4}$ seer *m.* (*Hesarubyalé*); (3) Plantain flower (without the sheath) 4 handfuls (*Balémothi volagina kusuma*); (4) Buttermilk 6 hornfuls (*Majjigé*). Boil the first three together in water, crush them finely, mix with buttermilk, and give once or twice.

Recipé 3.—Give 7 or 8 hornfuls of stale '*ragi*' *conjé*, mixed with half its quantity of buttermilk.

Recipé 4.—Recipé 10 under Hæmaturia is also used. *Conf. p. 10.*

TETANUS. (*Bigiroga—Hellugadibuselsvasalavu.*) **LOCK-JAW.**

NATIVE TREATMENT.—The animal is branded in a circuitous line commencing on the outer side of the left thigh just above the hock; the line runs up the hip and continues along the barrel on the left side parallel to the vertebral column, about 9 inches from it, and then over the shoulders and neck and on to the face. It is thence continued on the right side through spots similar to those on the left, ending at a point above the right hock.

SPRAINS, DISLOCATION AND FRACTURES.

(*Ulaku; Málé heraluvada; Mulé muriyuvadu.*)

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Gingelly oil 3 tolas (*Vallellenné*); (2) Black gram-flour a handful (*Uddinahittu*). First

SPRAINS AND FRACTURES.

Country remedies and treatment.

rub the affected part well with oil and then coat it with the flour and splint it. Repeat the process every second or third day and continue for a week or a fortnight or till the animal gets better. Care should be taken to keep the animal in perfect rest and feed it well.

Recipé 2.—Take of—(1) Eggs 3 (*Kolimotté*); (2) Black gram-flour a handful (*Uddinalúttu*); (3) Leaves of **Dodonæa viscosa** 2 handfuls (*Bandari Soppu*). First rub the injured part well, passing the hands in the direction in which the muscles stretch, apply the albumen of eggs and coat it with the flour. Finally arrange a layer of leaves over the coating and set up the limb with bamboo splints, and keep changing the bandage every other day; continue the treatment for eight or ten days, giving the animal perfect rest, and nourishing it by giving the following preparation—(1) *ghi* ¼ seer *m.* (*Thuppa*); (2) Eggs 5 (*Kolimotté*); (3) Leaves of **Tephrosia tinctoria** 3 handfuls (*Battéharakimagida*). Express the juice of the leaves, mix with *ghi* and albumen of the eggs and give twice a day.

Recipé 3.—Take of—(1) Leaves of **Canna indica** 3 handfuls (*Maragadé Soppu*); (2) Oil of **Guizotia abyssynica** $\frac{1}{16}$ seer *m.* (*Huchchellu*) *ram til*). Express the juice of the leaves, mix the oil, and apply to the affected part and rub well against the grain of the hair. Then place a layer of the leaves of the same kind and put the splints on; repeat this three or four days.

In cases of fracture and dislocation care is taken to keep the broken ends or the dislocated bones in position, before treatment.

BRONCHITIS.

BRONCHITIS. (*Kemmu.*)

Native Treatment.—*Recipé* 1.—Take—(1) Leaves of **Dæmia extensa** (*Halukuratigé Soppu*); roll them in wet cloth slightly heated, and then express the juice and give 1 hornful a day, for two days.

Recipé 2.—Give lime water for three days, 2 hornfuls a day.

Apart from other remedial measures, it is necessary to clear the bowels by a dose of common salt (16 tolas in tepid water) and rub the neck and chest along the course of the windpipe with a mixture of gingelly oil and mustard, finely ground together, repeating the latter process if necessary.

CATARRH.

CATARRH. (*Salé.*)

Catarrhal affection may be only slight or aggravated; when slight it is called "Salé." When severe 'Anselé' or 'Doddaselé.'

Native Treatment.—*Recipé* 1.—Take of—(1) Black pepper 2 tolas (*Menasu*); (2) Scaly coats of garlic 2 tolas (*Bellulli hottu*); (3) Omum seeds 2 tolas (*Omu*); (4) Butter 6 tolas (*Binni*). Pulverise (1), (2), and (3) together, mix with butter and give in 3 hornfuls of warm water; touch the eyes once with a paste of ginger finely ground in water.

Recipé 2.—Take of—(1) Black pepper 2 tolas (*Menasu*); (2) Garlic 1 tola (*Bellulli*); (3) Leaves of **Capparis zeylanica** a handful (*Thottisoppu*). Grind all well together, mix in water, and give 3 hornfuls once only; and apply the ginger paste to the eyes as above.

Mysore. (*A. Kristnasamiengar.*) **OXEN.**

CATARRH.

Country remedies and treatment.

Recipé 3.—Take of—(1) Bulbs of **Crinum** sp. 2 seers w. (*Kaduneerulli*); (2) Elephant's dung (fresh) 5 seers w. (*Aniladdi*). Crush the two together and mixing water express the liquid and give 2 hornfuls, once.

Recipé 4.—Grind chillies (3 tolas) with water and give a hornful of the mixture as a drench, once, and bleed the animal, opening the tip of the ear.

Recipé 5.—Take of—(1) Leaves of **Lettsomia** sp 2 handfuls (*Uganihunbina soppu*); (2) Garlic cloves 1 tola (*Bellulli hilaku*); (3) Black pepper 2 tolas (*Menasu*). Grind them all together, mix with 3 hornfuls of buttermilk, and give once.

Recipé 6.—Take of—(1) Roots and shoots of **Andropogon Schœnanthus** 6 tolas (*Kachimanté*); (2) Bark of **Thespesia populnea** 24 tolas (*Hoovarsichakké*); (3) Round fruit of **Acacia concinna** 3 tolas (*Gantuseegékoyi*). Crush them all together finely, add water, strain and give 3 hornfuls as a drench.

Recipé 7.—Apply hot iron along the back (on the "*sooli*") and make a line 4" long; or pour 3 or 4 drops of boiling oil on the "*sooli*."

Recipé 8.—Take of (1)—Tender shoots of **Wrightia tinctoria** 4 tolas (*Murabalékoodi*); (2) Black pepper 2 tolas (*Menasu*). Grind them together, mix in 3 hornfuls of tepid water, and give as a drench.

Recipé 9.—Take of—(1) Ginger dry ½ tola (*Sunti*); (2) Seeds of small fennel ½ tola (*Karijeerigé*); (3) Leaves of **Leucas zeylanica** 3 tolas (*Thumbé soppu*). Pulverise the first two and mix with the expressed juice of the leaves, strain and drop 20 minims of the mixture into the nostrils, once.

In aggravated cases of catarrh:—

Recipé 10.—Throw a few drops of boiling castor oil on the "*sooli*" and also at the hollow between and behind the horns, and bleed the animal, opening the tip of the ear.

Recipé 11.—Take of—(1) Bark of **Poinciana elata** pounded 2 seers w. (*Kenkesaré chakke*); (2) Mustard, pulverised, 3 tolas (*Sasuvé*); (3) Buttermilk 3 hornfuls (*Majjigé*). Mix together, strain and give as a drench; also touch the eyes with this mixture, when there is no flow from them.

Recipé 12.—Take of—(1) Ginger, pulverised, 3 tolas (*Sunti*); (2) Black pepper 2 tolas (*Menasu*); (3) Garlic, ground fine, 4 tolas (*Bellulli*); (4) Leaves of **Dæmia extensa** 3 hornfuls (*Halukuratigé soppu*). Express the juice of the leaves, mix the other ingredients and give.

EMACIATION AND WEAKNESS (CHRONIC). (*Vananaradi—Naranaradi—Pinjadi naradi—Kasiroga.*)

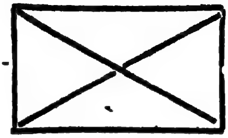
ANÆMIA.

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Leaves of **Breynia rhamnoides** 1 handful (*Bili Sulisoppu*); (2) Black pepper 2 tolas (*Menasu*); (3) Garlic 1 tola (*Bellulli*); (4) Buttermilk, 3 hornfuls (*Majjigé*). Crush the first three together finely, mix buttermilk, strain and give, once a day, and continue for three or four days.

ANÆMIA.

Country remedies and treatment.

Recipé 2.—The animal is branded on the spine in the following form. This is particularly done when the brain is affected :—

Vertebral -------  ------- Column.

Recipé 3.—Recipé 3 under SPLENIC APOPLEXY is also useful in this case.

Recipé 4.—Take of—(1) Leaves of **Leucas zeylanica** 2 handfuls (*Thumbé soppu*) ; (2) Water or buttermilk 3 hornfuls (*Neeru Athava majjigé*). Crush the leaves finely, mix with water or buttermilk, strain and give once a day, for three days

Recipé 5.—Secure the deposit found at the bottom of toddy vessels and give 2 hornfuls each day, from three to seven days.

Recipé 6.—Take of—(1) Black pepper 3 tolas (*Menasu*) ; (2) Ginger dry 2 tolas (*Sunti*). Pulverise and mix in 2 hornfuls of water and give ; continue for three or four days.

This is supplemented by branding in dots between the ribs, the dots being placed in two or three parallel lines on either side of the vertebral column.

Recipé 7.—Take of—(1) Green turmeric 10 tolas (*Hasi Arasina*) ; (2) Species of Orchid (?) 12 tolas (*Dommégaddé*) ; (3) Onions 1 seer *w.* (*Neerulli*) ; (4) Bark of **Ailanthus excelsa** 2 seers *w.* (*Doddamarada chakké*). Crush them all and mix in three hornfuls of buttermilk, strain and give once a day and continue for three or four days.

Recipé 8.—Take of—(1) Bark of lemon tree (**Citrus Medica**, var. 2. **limonum**) (*Héralé chakké*) ; (2) Bark of sour lime (**Citrus Medica**, var. 3. **acida**) (*Nimbéchakké*) ; (3) Bark of **Azima tetracantha** (*Bilicappichakké*) ; (4) Bark of **Toddalia aculeata** (*Kadumenasigé chakk*) ; (5) Bark of **Wrightia tinctoria** (*Marahalé chakké*) ; (6) Bark of **Cordia** sp. (*Thapasi chakké*) ; (7) Bark of **Ægle Marmelos** (*Bilvapatré chakké*) ; (8) Bark of the banyan (*Huttualadamaradu chakké*); (9) Bark of **Cassia Fistula** (*Kakkechakké*) ; (10) **Vitis quadrangularis** (*Naraléhambina-kudi=Mangarulli*) ; (11) Bark of **Jatropha Curcas** (*Huchla haralu=Kacharallu chakké*); (12) Bark of **Randia** sp. (*Nagaréchakké*) ; (13) Bark of **Butea frondosa** (*Muthagara chakké*) ; (14) Bark of **Eriodendron anfractuosum** (*Biliburaga chakké*) ; (15) Roots of **Cucumis trigonus** (*Dasa mekké béru*) ; (16) Roots of **Solanum** sp. (*Bilinelagullada béru*) ; (17) Bulbs of **Withania somnifera** (*Hirimaddinagaddé*) ; (18) Roots of Indian birthwort, **Aristolochia indica** (*Eswaribéru*) ; (19) Leaves of **Leucas zeylanica** (*Kahittumbé soppu*) ; (20) Leaves of **Tylophora asthmatica** (*Adumuttadagida*) ; (21) Roots of **Andropogon Schœnanthus** (*Kachihullugaddé*) ; (22) Bark of **Capparis zeylanica** (*Thotlichakké*); (23) Bark of Tanner's Cassia (*Avarikė chakké*) ; (24) Bark of **Gardenia turgida** (*Budakaré chakké*) ; (25) Coriander seed 2 seers *m.* (*Kothambaribuja*) ; (26) Onion as many seers measure as coriander (*Neerulli*) ; (27) Turmeric ½ seer *m.* (*Arasina*). Take about a handful

ANÆMIA.

Country remedies and treatment.

of each of the ingredients from (1) to (24), using a little more of (3), (4), (5), (6) and (7) and a little less of (15), (16), (17) and (18). Grind all together finely, fill an old pot with the powder, adding equal quantities of water and buttermilk so as to cover the powder. Close the mouth and bury the pot in a manure pit for three days. From the fourth day take 2 hornfuls of the liquid mixture daily and give it as a drench; replenishing each time the pot with as much buttermilk as has been taken out of it. Continue this for ten or twelve days. The preparation may be kept for several months if in daily use, and at the end all the solid remnants may be given to lean and sickly animals. This may be, it is said, usefully employed in 'Splenic Apoplexy' and 'Pneumonia' also, but should be withheld from cows with calf for fear of inducing abortion.

Recipé 9.—Take of—(1) Roots of **Plumbago zeylanica** 12 tolas (*Chitramu-ladabéru*); (2) Bulb and leaves of **Withania somnifera** 24 tolas (*Hirimaddina soppu mathu gaddé*); (3) Ginger pulverised 4 tolas (*Sunti*); (4) Small fennel pulverised 2 tolas (*Kariyeerigé*). Grind (1) and (2) finely, adding water, and mix (3) and (4) and give 3 hornfuls a day; and continue for three days.

DROPSY.

DROPSY. (*Bavu.*)

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Milk of **Calotropis gigantea** 1 tola (*Yekkadahalu*); (2) Cow's butter 2 tolas (*Hasurina benné*). Mix them well and apply it once, in half an inch circular dots, to the inside of that thigh on which swelling is present. Sometimes the dots are made one on each flank, one on the perinæum and another lower down between the thighs.

Recipé 2.—Take of roots, bark and leaves of **Alangium Lamarckii** 3 handfuls (*Ankolé Sahamála*). Grind all together, mix and give in 3 hornfuls of '*conji*.'

Recipé 3.—Lard is melted and given with hot water or '*conji*' as a drench.

Recipé 4.—In local dropsy, if the neck is affected, it has a tendency to spread. To prevent this, brand all round it at once, so as to confine the swelling.

Rub the swollen part applying a little *ghi*, and coat the part with a mixture of turmeric and common salt powders and then foment it with a warm vessel full of live charcoal. Repeat this last process several times.

Recipé 5.—Take of—(1) Pigeon pea ½ seer *m.* (*Thogari halu*); (2) Mustard powder 3 tolas (*Sasuvé*); (3) Round fruit of **Acacia concinna** powdered 3 tolas (*Gantuseegékayi*); (4) Ginger powder 3 tolas (*Sunti*); (5) Turmeric powder 1 tola (*Arasina*); (6) Black pepper powder 3 tolas (*Menasu*); (7) "*Cumboo*" flour ½ seer *m.* (*Sajjéhittu*). Boil pigeon pea in a large quantity of water, decant and secure the liquid extract, add the other ingredients and give 6 hornfuls of the mixture.

Apart from remedial measures, opening the bowels daily and frequently rubbing the animal help to successful treatment. The animal is covered

'HAMPAR-ALE.'

with a wet sheet in the early stage. If the animal is unable to feed, rice '*conji*' is given. Drinking water is either discontinued or given sparingly, having previously dissolved in it 4 or 5 tolas of nitre.

Country remedies and treatment.

'HAMPARALÉ.' (*Hamparalé = Pamparigaddé.*)

This appears as a swelling at the angles of the jaw a little behind and below the ear; abscess then forms and bursting produces obstinate sores, the animal sometimes dying by suffocation when the air-passages are also involved. In some cases the swelling of the parotid gland is followed by similar inflammation and swelling of the glands of the neck. These swellings even when partially cured are liable to reappear and often trouble the animal from time to time.

NATIVE TREATMENT.—*Recipé* 1.—Apply hot iron and brand all round and over the swelling. Then give 2 hornfuls of an emulsion of asafœtida (*Ingu*) ½ tola dissolved in buttermilk, twice a day, for three days.

Recipé 2.—In the two holes found in the lower flat surface of the upper dental pad, thin reeds of uniform thickness such as of the common broomstick are thrust, one in each, and left there to rot. As the reeds rot the swellings are said to disappear.

HYDATIDS ON THE LIVER.

HYDATIDS ON THE LUNGS AND LIVER. (*Dommémathu kari Yuruvagala hunnu mathu avugalal liaguva gantu.*)

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Bark of **Randia dumetorum** 24 tolas (*Gandukaré chakké*); (2) Bulbs of **Colocasia antiquorum** 24 tolas (*Kesaradantina gaddé*); (3) Turmeric powder 1 tola (*Arasinapudi*). Crush (1) and (2) finely, mix all and soak in 3 hornfuls of sour buttermilk for three days in an earthen pot, strain and give the mixture every evening, and continue for three or four days or longer if necessary.

Recipé 2.—Take of—(1) **Adhatoda Vasica** 1 handful (*Addasarpada salé*); (2) White onions 1 seer w. (*Bili neerulli*); (3) Sea-salt 3 tolas (*Kallu uppu*); (4) Roots of long pepper plant 4 tolas (*Mudi*); (5) Zedoary 2 tolas (*Kasthuri arasina*); (6) Cloves 1 tola (*Lavanga*); (7) Black pepper 3 tolas (*Menasu*). Pulverise all these, and macerate in 3 hornfuls of buttermilk for a few hours, shake and give every evening for three days.

SNAKE-BITE.

SNAKE-BITE. (*Havukachiddakké.*)

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Leaves of **Vallaris Heynei** 1 handful (*Vishamalligé soppu = Bugadi hambu*); (2) Buttermilk 2 hornfuls (*Majjigé*). Crush the leaves well, mix in buttermilk, strain and give as a drench.

Recipé 2.—Take of—(1) Bark of **Anogeissus latifolia** 12 tolas (*Dindagada chakké*); (2) Bark of **Butea frondosa** 12 tolas (*Muthugada chakké*); (3) **Argemone mexicana** plants 1 handful (*Dathurigida*). Crush all these together, express the juice and give 2 hornfuls as a drench.

Recipé 3.—Take of—(1) **Wrightia tinctoria** leaves 6 tolas (*Maraahalé soppu*); (2) Black pepper 2 tolas (*Menasu*); (3) Garlic 2 tolas (*Bellulli*); (4) Hot water (*Bisineeru*). Grind the first three, mix in one hornful of hot water, and give the mixture when tepid

Mysore. (*A. Kristnasamiengar.*) | **OXEN.**

SNAKE-BITE.

Recipé 4.—Take of—(1) Leaves of **Wrightia tinctoria** 1 handful (*Ma a halé soppu*); (2) Black pepper 2 tolas (*Menasu*); (3) Garlic 2 tolas (*Bellulli*); (4) Leaves of **Tylophora asthmatica** 1 handful (*Adumuttadasoppu*); (5) Buttermilk 3 hornfuls (*Majjigé*). Grind the first four together, mix in buttermilk, strain and give as a drench, once; also apply the same preparation to the bitten and swollen parts.

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Recipé 5.—Take of—(1) Leaves of **Wrightia tinctoria** 1 handful (*Marahalé soppu*); (2) Buttermilk 3 hornfuls (*Majjigé*). Grind the leaves in buttermilk, strain the mixture and give as a drench once.

Recipé 6.—Take of—(1) Ivorywood (**Wrightia tinctoria**) leaves 1 handful (*Marahalé soppu*); (2) Roots of **Tylophora asthmatica** 6 tolas (*Adumuttadabéru*); (3) Buttermilk 3 hornfuls (*Majjigé*). Grind the first two together, mix in 3 hornfuls of buttermilk and give as a drench.

MAGGOTS IN WOUNDS, ETC.—(*Hulithaghayakké.*)

MAGGOTS.

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) **Gardenia lucida** resin ½ tola (*Bikké mallé*); (2) Tobacco 1 tola (*Hoge soppu*); (3) Tender shoots of milk hedge 2 tolas (*Kolakalli chigaru*). Grind all the three together and apply to the sore containing maggots. If the sore is deep, it may be stuffed with this preparation. The maggots are said to fall off within three days.

Recipé 2.—Take of—(1) **Gardenia lucida** resin ½ tola (*Bikké mallé*); (2) Camphor 1 tola (*Karpura*); (3) **Trichosanthes palmata** seeds 2 tolas (*Kagémaribuja*); (4) Cocoanut oil a sufficient quantity (*Kobari Yenné*) Pulverise the first three, mix with cocoanut oil and apply to the sore, and do not allow the animal to lick it.

Recipé 3.—Take of—(1) Seed-pulp of **Trichosanthes palmata** 2 tolas (*Kagémaribuja*); (2) Gingelly oil 4 tolas (*Ollellenné*); (3) Camphor 1 tola (*Karpura*). Grind the seed-pulp and camphor in the oil, apply the liniment to the sore and picket the animal immediately, for an hour or two in the sun. If the wound is a long-standing one, due to burrowing by insects as is usual in neglected cases of foot and mouth disease, it is first cauterised and then the above preparation applied, taking care not to allow the animal to lick the spot.

Recipé 4.—Grind the tender shoots of bamboos into fine thick paste, stuff the sore with it and bandage it.

Recipé 5.—A liberal application of the milky juice of the banyan to the sore is also said to kill the insects.

WORMS IN THE INTESTINES. (*Janthupulakké.*)

WORMS.

NATIVE TREATMENT.—*Recipé* 1.—Take of—(1) Leaves of American aloe (**Agave americana**) (*Kathalipatté*); (2) Turmeric powder 3 tolas (*Arasinapudi*). Slightly heat the aloe leaves and express 1 or 2 hornfuls of the juice, add turmeric powder and give as a drench, once only. Should purging become severe, give a drench made of a mixture of onions and buttermilk ground together Buffaloes are more affected with worms than cows and bulls.

Recipé 2.—When young and sucking calves suffer from worms, as is often the case:—Take of—(1) Leaves of **Artemisia vulgaris** a handful (*Machipatré*); (2) Sweet flag 1 tola (*Bajé*); (3) Butter (*Benné*). Grind (1) and (2) together, make a ball, add equal quantity of butter, mix and give in 2-tola doses; once a day for three days.

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1896—No. 29.

RUMEX NEPALENSIS.

(NIPAL DOCK-ROOT.)

[*Dictionary of Economic Products, Vol. VI., Pt. I.*, R. 648.]

THE OCCURRENCE OF CHRYSOPHANIC ACID IN CERTAIN INDIAN PLANTS.

Paper by DR. O. HESSE, *of Stuttgart, translated from 'Liebig's Annalen der Chemie,' 27th February 1896, revised and edited. With an Introduction by* MR. D. HOOPER.

INTRODUCTORY.

The investigation of **Rumex nepalensis** or Nipal Dock-root originated in the following manner.

About two years ago the margin of the Ootacamund lake was ordered by His Excellency Lord Wenlock, in consultation with Mr. Lawson, the Government Botanist, to be cleared of all noxious vegetation and unsightly trees, and to be completely renovated. One of the most abundant of the weeds forming the undergrowth to be removed from the land was this species of **Rumex** which exuded when fresh some orange-coloured juice, that stained the hands, and turned deep red in the process of drying. The dried roots had the odour of rhubarb, and I was able to separate from them a yellow principle having the characteristics of chrysophanic acid. As Dr. Hesse, of Stuttgart, was at that time investigating the chemical principles found in rhubarb root, he was regarded as the proper person to conduct an examination of an allied vegetable product. My chief object in

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having the root analysed was to find out if a supply of chrysophanic acid could be obtained readily from so common a weed. This acid in the form of "Goa Powder," an article imported from Brazil, is largely used by the natives of this country for skin diseases. Its action is peculiarly adapted for ringworm and pitryasis, and it seldom fails to effect a cure when properly applied.

Goa Powder

Goa Powder was introduced into India by the Portuguese more than a hundred years ago. Mr. D. S. Kemp, of Bombay, was the first to draw attention to this substance in 1864 as a secret remedy used by the natives for skin disease. Dr. Attfield in 1875 made a complete examination of it and obtained chrysarobin which he supposed to be chiefly chrysophanic acid. Chrysarobin is present in Goa Powder to the extent of about 70 per cent., and when dissolved in strong potash solution and agitated in the air, it yields chrysophanic acid. Goa Powder is probably identical with the Araroba or Bahia powder from Brazil. In 1879 the botanical source of this powder was determined to be **Andira araroba**, *Aguiar*, a large tree of the leguminous order common in the damp forests of Brazil. Sir J. Fayrer, K.C.S.I., subsequently wrote on the medicinal uses of Goa Powder and recommended it to Europeans for herpes, tinea and erythema. The mode of application is to dissolve a few grains of the powder in vinegar or lime juice and paint the solution over the eruption as required.

Properties of the pure acid

Description and properties of pure chrysophanic acid according to the analyses of Grandis (1893), Andonard (1894) and Hesse (1895).—It occurs in small lamellar crystals of a yellowish colour and has a composition represented by the formula $C_{15}H_{10}O_4$. The melting point varies between 162° and 187°, whereas the sublimed acid melts at 190-191°. It is insoluble in water, soluble in 224 parts of boiling alcohol of 86 per cent., or in 1,125 parts at 30°. It is soluble in acetic acid, chloroform, benzol, and with a red colour in alkaline solutions. Sulphuric acid forms with it a red solution and caustic potash a blue one. Although obtained from different commercial sources these properties of the acid may now be regarded as fairly constant.

Chemistry of the Polygonaceæ.

The work of Mr. A. G. Perkin on the constituents of the root of **Polygonum cuspidatum** (*Conf. Agricultural Ledger, 1896, No. 7*) has extended our knowledge of the chemistry of one of the plants of the natural order Polygonaceæ, and it will be interesting to ascertain

how the Dock, Bistort and Rhubarb, members of the same family, are chemically related to one another. Mr. Perkin detected in **Polygonum** root a glucoside of emodin which he describes under the name of *polygonin*. Emodin and chrysophanic acid are connected in so far as the former is trioxymethylanthra-quinone and the latter, which is present in rhubarb, is dioxymethylanthra-quinone. The rumicin and lapathin of old investigators have on more than one occasion been referred to as a crude form of this particular acid. The present report of Dr. Hesse on **Rumex** will form a companion paper to that of Mr. Perkin on **Polygonum**. INTRODUCTORY.

As an introduction to Dr. Hesse's paper it will be convenient to collate what information we possess on the uses and properties of the species of **Rumex** indigenous to India.

R. ægyptiacus, *Linn.*, Egyptian Dock.—This plant occurs in Sind, where under the name of *chooka* its roots are used as a dye.

R. conglomeratus, *Mur.*, **R. dentatus,** *Linn.*, **R. hastatus,** *Linn.*—These plants are common in the Panjab and Sind, and the roots are employed as dyes and astringents.

R. obtusifolius, *Linn.*—An ubiquitous plant of Europe, Asia and America. It grows in Sind where its roots are esteemed medicinal. This root and probably that of **R. vesicarius,** *Linn.*, constituted the *Radix spathiacuti* of old writers on medicine. A decoction was largely employed as an astringent application for cutaneous affections.

R. nepalensis, *Spreng.*—Dr. Irvine says the roots of the Nepal Dock are sold in the bazars of Bengal under the name of *Rewandchini* as a substitute for rhubarb. The powder is given in constipation in doses of 10 to 120 grains.

The Indian dock roots may be summarised as being medicinally applicable for skin complaints and similar to rhubarb as a stomachic; in the arts, they have been recognised to a small extent as a dyeing agent. These properties are compatible with those of drugs which contain chrysophanic acid, as this acid is often associated with colouring matters possessing tinctorial applications.

Besides the species of **Rumex** and **Rheum** (Rhubarb) which are said to contain chrysophanic acid or a similar body, there are several plants in India which are used for ringworm and kindred skin complaints which do not belong to the order Polygonaceæ. They are enumerated in the following list with the hope that their Indian sources of chrysophanic acid.

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uses as substitutes for Goa Powder may be more generally known :—

Cassia alata, *Linn.*—This is now naturalized in India, having been introduced from the West Indies, where it has a reputation for skin diseases. Its Bengal name is *Dadmardan* signifying 'ringworm shrub.' M. Porte, a French physician in Egypt, found the leaves to contain chrysophanic acid, and used with much success an ointment prepared from them for the cure of the above-named complaints.

C. occidentalis, *Linn.*—Professor Clonet in 1876 discovered a colouring matter acrosine in the seeds of this plant. The substance when separated has a melting point of 245° and in other respects is allied to if not identical with emodin, an anthraquinone derivative related to chrysophanic acid.

C. sophera, *Linn.*—This plant is also used for cutaneous affections, notably in dhobies-itch. The Singhalese doctors have adopted the method of frying the leaves in oil and applying the oil to the affected part. Chrysophanic acid being soluble in oil, the active principle of the leaves is efficiently removed by this process.

C. Tora, *Linn.*—The leaves of this shrub are also used for itching skin eruptions, and its name *Chakramarda* signifies 'ringworm destroyer.' It is also used as a dye. In 1888 Mr. Elborne found the source of the colouring matter of the seeds to be similar to emodin, a principle mentioned as having been found in **C. occidentalis**.

C. angustifolia, *Vahl.*—This shrub yields the well known medicinal senna leaves, and although not a native of India, it is placed in this list as having a similar composition to the leaves of other members of the genus **Cassia**. Cathartin, the active principle of Senna, has been investigated by Dr. Bourgoin, who reported it to consist of chrysophanic acid, glucose and other substances.

Rhinacanthus communis, *Nees.*—Used for tinea. Dr. Liborius analysed the root in his laboratory at Dorpat and found rhinacanthin to resemble chrysophanic acid in its antiseptic and antiparasitic properties.

Rheum emodi, *Wall.*—Dr. Watt noticed in Kullu a large trade being carried on in the roots of this plant, and was told that they were used externally for sores and skin diseases.

There are other leaves of leguminous plants, for instance **Cynometra ramiflora**, *Linn.*, which are used for cutaneous eruptions, and probably owe their curative action to the presence of chrysophanic acid.

R. 648.

EXAMINATION OF THE ROOT.

Another plant removed botanically from all those previously mentioned may also be found to contain this acid. This is the **Xyris indica,** *Linn.*, a native of Bengal, where it is much esteemed as a cure for the troublesome eruption called ringworm. The writer has had an opportunity of examining the species **X. schœnoides,** *Mart.*, growing on the Nilgiris and found a crystalline colouring matter giving a purple red solution with caustic potash, but the quantity was so small as to admit of no complete analysis.

On the ROOT of RUMEX NEPALENSIS, Spreng.

By Dr. O. Hesse of Stuttgart.

(From *Liebig's Annalen der Chemie, 27th February 1896.*)

In Madras and other parts of India a species of **Rumex** grows wild, the roots of which are well known to the natives for their astringent properties, and are used for medicine and dyeing purposes. Mr. D. Hooper, of Ootacamund, has examined this root and he informs me that he believes it contains chrysophanic acid. As I have shown that the chrysophanic acid of **Parmelia parietina** is different to the acid found in rhubarb, Mr. Hooper requested me to repeat his examination of **Rumex nepalensis,** and supplied me with a quantity of the material for that purpose. My investigation has shown that this root does not contain chrysophanic acid, under which name I understand the substance contained in rhubarb, but an extremely similar substance which, with reference to its origin, I call *Rumicin.* This substance is accompanied in the root by two other bodies, *Nepodin* and *Nepalin.*

After the root, in fine powder, is extracted with ether in a reflex condenser, there remains a yellowish brown solution which, as it becomes concentrated, throws out brittle crystals. After continued percolation with ether the root will be only slightly coloured, but on the addition of hot alcohol a solution is formed having an intense yellow colour which on evaporation leaves a golden yellow resin dissolving in potash solution with a purple red colour. As I could not succeed in obtaining crystals from this resin, it is not taken into account in this examination.

With reference to the above-mentioned ether extract, the crystalline matter was filtered off and the filtrate distilled to one half of its

EXAMINATION OF THE ROOT.

original volume. The crops of crystalline material were mixed together and treated with solution of potassium carbonate. The brown solution which resulted became darker on exposure to the air and was rapidly filtered. The filtrate was saturated with hydrochloric acid and ether added, and on distilling the ether there remained the Nepodin with amorphous colouring substances. The portion of the mass insoluble in potassium carbonate was then boiled with acetone in which the Rumicin dissolved, but the Nepalin remained behind.

RUMICIN.

As the acetone solution cooled there were formed leafy crystals melting at about 182°. These crystals were separated from the mother liquor, washed with a little acetone, and when perfectly dry, they were dissolved in hot benzol. This solution was mixed with three or four times its volume of petroleum ether, boiled for a short time and filtered, whereby a brown flocky body was removed. During the process of cooling beautiful spangles are formed which become perfectly pure on being re-crystallised from benzol-petroleum ether—

0·1207 gr. dried at 100°, gave 0·3135 CO_2 and 0·0442 H_2O.

So the Rumicin has the same composition as chrysophanic acid and is analogous to the formula $C_{15} H_{10} O_4$.

	Calculated.	Found.
C	70·86	70·83
H	3·94	4·06

Rumicin occurs in the form of lamellæ having a metallic lustre, which, however, do not appear so intensely golden yellow as chrysophanic acid. It dissolves readily in hot alcohol, acetone, glacial acetic acid, but only slightly at common temperatures, easily in chloroform and acetic ether, but hardly at all in petroleum ether or ligroin. It melts at 186-188°; with potash solution it gives a purple red solution which becomes discoloured when exposed to the air, and in consequence of the absorption of carbonic acid, the Rumicin is deposited. With an aqueous solution of potassium carbonate it becomes slightly pink coloured. If heated with alcoholic potash and cooled, fine purple coloured prisms are produced which, however, turn yellow on exposure to the air. It dissolves with a purple colour in sulphuric acid and from the solution it is deposited

EXAMINATION OF THE ROOT.

in yellow flocks on the addition of water. If heated with hydriodic acid, according to Zeisel's process, it developes no alkyl-iodide, but it forms a body which is identical with that which is produced under the same circumstances from chrysophanic acid and which has been named chrysophan-hydranthron.

The only real difference between Rumicin and chrysophanic acid is accordingly in the melting point, and it might be assumed that Rumicin being a physical isomer of chrysophanic acid, the one could be converted into the other; but after numerous trials I have not succeeded in this direction.

Nepalin.

The crude substance, before described, as being insoluble in hot alcohol and acetone, consists mostly of *Nepalin.* Nepalin is easily separated from the mass by the employment of boiling benzol in which the Nepalin is soluble. If to this boiling solution three or four times the volume of petroleum ether is added, a large quantity of dark brown deposit is formed which is separated by filtration. From the nearly clear solution a large crop of crystals of Nepalin form as it cools, and by recrystalling from boiling glacial acetic acid it is obtained perfectly pure. Nepalin forms orange-coloured microscopic needles which melt at 136° to a red fluid. It is not volatile, but is decomposed at high temperatures. Heated at 100° it does not show a loss of water of crystallisation—

0·2082 gr. air-dried gave 0·5505 CO_2 and 0·094 H_2O.

This result corresponds with the formula $C_{17} H_{14} O_4$.

	Calculated.	Found.
C.	72·34	72·11
H.	4·96	5·01

Nepalin dissolves readily in hot, but to a small extent in cold glacial acetic acid, easily in benzol and chloroform, fairly well in alcohol, acetone and ether; by boiling it dissolves a little more freely than at common temperatures. In petroleum ether it dissolves only very slightly with a yellow colour. With potash solution it dissolves almost entirely giving a purple-coloured solution, and when exposed to the air through absorption of carbonic acid the Nepalin separates as a yellow crystalline precipitate. In aqueous

EXAMINATION OF THE ROOT.

solutions of potassium or sodium monocarbonate it is nearly insoluble. Very little of it dissolves in ammonia even when heated, but the solution reddens and gives with barium chloride and sugar of lead dirty coloured flocculent precipitates. It dissolves with a blood red colour in concentrated sulphuric acid, and by adding a little water the Nepalin separates unchanged in yellow flocks.

If the Nepalin becomes heated with hydriodic acid, according to Zeisel's process, it does not develop alkyl-iodide; it changes into a brown resin which liquifies on exposure to the air. If treated with acetic anhydride the Nepalin absorbs acetyl for hydrogen, but to make the action complete they must both be heated together in a closed tube at a temperature of 140-150° for some hours. The solution, still warm, is then poured into a shallow vessel, and the acetyl derivative crystallises out. The crystals are separated from the mother liquor and recrystallised first with hot alcohol and then with a little boiling acetic ether. This combination forms brown yellowish shining crystals, mostly rhomboids. It darkens in colour at 170° and melts at 181° to a black liquid. The air-dried substance shows a loss up to 130°—

I. 0·1970 gr. dried in exsiccator gave 0·4985 CO_2 and 0·0905 H_2O.
II. 0·2105 „ „ „ 0·5315 CO_2 „ 0·1005 H_2O.

	Calculated for $C_{17}H_{12}(C_2H_3O)_2O_4$	Found. I.	Found. II.
C. . .	68·85	68·73	68·82
H. . .	4·92	5·10	5·30

The diacetyl-nepalin dissolves rather easily in boiling chloroform and alcohol and very easily in hot glacial acetic acid from which, on cooling, it separates in micro-crystals. It is not acted upon at once by potash solution, but after standing for some time it splits up into nepalin and acetic acid. This reduction is greatly facilitated by boiling and the addition of a little alcohol, whereby the purple colour is at once produced.

NEPODIN.

(The word *Nepodin* is derived from "Nepal" and "Emodin". Nepodin is separated from its congeners by the employment of potassium carbonate just as *emodin* is from chrysophanic acid.) This substance is purified in the same way as the others and separates

EXAMINATION OF THE ROOT.

from the hot solution in long, brittle, greenish yellow prisms. It melts at 158° and is dissipated at a higher temperature without giving a sublimate. At 120° it does not show a loss in weight.

0·1602 gr. dried at 120° gave 0·4283 CO_2 and 0·0835 H_2O.

From which is calculated the formula of nepodin $C_{18}H_{16}O_4$.

	Calculated.	Found.
C.	72·97	72·94
H.	5·41	5·79

Nepodin dissolves readily in alcohol, acetone, ether, chloroform and acetic acid, and crystallises in prisms. In benzol it dissolves very easily, but if petroleum ether or ligroin is added to the solution the substance is obtained in magnificent crystals. In alcoholic solution it does not exhibit any acid reaction. It dissolves in a watery solution of potassium or sodium monocarbonate. This solution is coloured yellowish brown with a tinge of red, but deepens on standing. It dissolves readily in potash solution, and in concentrated sulphuric acid with an intense yellowish-red colour. Water added to the latter solution separated the substance unchanged in yellow flocks.

Ammonia easily dissolves nepodin, colouring it yellowish brown, and barium chloride and sugar of lead form in the solution yellowish gray amorphous precipitates. If heated according to Zeisel's process, alkyl-iodide does not develop, but the nepodin becomes changed into a blackish brown resin. It forms a crystallisable derivative if treated for six hours at 85° with an excess of acetic anhydride; by this means the nepodin first dissolves and then large rhombic plates of a pale yellow colour form which are insoluble in potassium carbonate. These crystals contain no water.

0·1063 gr. air dried, gave 0·2705 CO_2 and 0·0515 H_2O.

The formula for this substance then is $C_{18}H_{14}(C_2H_3O)_2O_4$.

	Calculated.	Found.
C.	69·47	69·40
H.	5·26	5·38

The diacetyl-nepodin assumes a dark colour at 180° and melts at 198°. It dissolves in a diluted solution of caustic potash, but when this liquor is boiled, the compound is split up into nepodin and acetic acid, and the solution becomes yellowish brown.

RUMEX nepalensis. **The Occurrence of Chrysophanic Acid in certain Indian Plants.**

EXAMINATION OF THE ROOT.

Results of examination reviewed.

Reviewing the above results, it is seen that the kind of **Rumex** in question contains quite a different series of substances compared with those found in Rhubarb. In the latter drug are the following substances, chrysophanic acid $C_{15} H_{10} O_4$, Emodin $C_{15} H_{10} O_5$ and Rhein $C_{15} H_{10} O_6$, which differ in the amount of oxygen they contain. In the **Rumex** root the constituents differ in their amounts of carbonic anhydride, and they must be regarded as homologues.

Rumicin	. . . . . .	$C_{15} H_{10} O_4$
* * * * *	*	*
Nepalin	. . . . . .	$C_{17} H_{14} O_4$
Nepodin	. . . . . .	$C_{18} H_{16} O_4$

A link between Rumicin and nepalin seems to be missing. Rumicin may form the link between the constituents of **Rumex** and **Rheum.** Von Thann says he has found in other kinds of **Rumex** that the Rumicin is identical with chrysophanic acid of rhubarb, but his grounds for this statement are not conclusive, and moreover by Von Thann's process a pure substance can never be obtained. A repetition of Von Thann's examination of **Rumex patienta** and **R. obtusifolius** and of Grothe on **Rumex maritimus, R. aquaticus, R. hydrolapathum** and **R. palustris** would be most desirable.

It remains to be proved whether Rumicin, by reduction with hydriodic acid, gives the same body as chrysophanic acid. I intend to make a further examination in this direction, as I have received a further consignment of the root of **Rumex nepalensis** from Mr. Hooper, to whom again I am much obliged.

G. I. C. P. O.—No. 411 R. & A. D.—9-11-96.—2,100 —H. R.

(Vegetable Product Series, No. 27.)
(Fibres.)

THE

AGRICULTURAL LEDGER.

1896—No. 30.

SANSEVIERIA ZEYLANICA.

(BOW-STRING HEMP.)

[*Dictionary of Economic Products, Vol. VI., Pt. II.,* S. 785.]

MURVA FIBRE AS A SECOND OR CATCH CROP FOR TEA PLANTERS.

Result of Examination of a Sample forwarded to the Imperial Institute; Commercial Valuations obtained thereon; together with Review of the Correspondence by THE EDITOR; ***and a Note on Cultivation by a West Indian Planter. To which is prefixed an Account of the Plant and mode of preparing the fibre.***

INTRODUCTORY.

The object of the inquiry indicated in the correspondence herein briefly reviewed is to discover a plant that might be profitably grown as a second or catch crop on those portions of Tea Estates not required or not suitable for tea. It is universally admitted that such a crop is much needed. Considerable attention has of late been given to the subject with the result that *Murva* fibre (**Sansevieria zeylanica**), or as it is known in trade Bow-string Hemp, may possibly come to be so cultivated.

The correspondence under review may be suitably prefaced by the following account of the plant and its fibre taken from *The Dictionary of Economic Products.*

The Bow-string Hemp (**Sansevieria zeylanica**) plant is a stemless bush with perennial roots, and a rosette of six to eight succulent, radical leaves, the inner of which are often four feet long, and end in a long straight spine, the scape or peduncle, one to two feet long, rising from the centre of the leaves. Flowers racemose, greenish-white, erect, four to six together in clusters. It is found on the eastern

INTRODUCTORY.

Habitat.

coast of India from Bengal to Madras; common on the Coromandel coast, in Cumbum, and in the Dindigul district. It is stated that in Malabar of which country it is a native, it does not produce seed. In India it may be said to exist under cultivation mainly. It is distributed to Ceylon, Java, and the coasts of China and Africa.

Fibre.

From the succulent leaves is extracted a fibre held in high esteem by the natives on account of its elasticity and consequent suitableness for bow-strings. . . . The fibre is used for the preparation of cordage and matting in the regions where it occurs, and is much valued in Europe for ropes used in deep sea dredgings . . .

Mode of preparing the fibre.

The fibre is pliant, soft, and silky, and much resembles that of the pine-apple. It is usually prepared by taking the fresh leaves and placing one of them on a smooth board which is raised at one end. The lower end of the leaf is then pressed down by the toe of the workman, who squats on the plank, and with a blunt knife or piece of iron plate scrapes upwards along the surface of the leaf and thus deprives it of its fleshy pulp by successive scrapings, turning the leaf over and over, as may be necessary. When the pulp is thoroughly removed, the fibre is washed for three or four minutes, and dried in the shade. Washing in brackish or salt water, or continuous soaking in water, is said to destroy the glossy white appearance of the fibre. With reference to the strength of *Murva* fibre Dr. Royle made some comparative experiments with this and Agave fibre, which showed that the two were about equal in strength. . . The thread made from *Murva* fibre is sometimes woven into fine cloths, which readily take on various dyes.

ORIGIN OF PRESENT INQUIRY.

On the 20th December 1895 (letter No. 1880), the Reporter on Economic Products forwarded to Mr. Royle, Curator, Indian Section, Imperial Institute, a small quantity of Bow-string Hemp or *Murva* (**Sansevieria zeylanica**) fibre. This had been received from Honourable J. Buckingham, C.I.E., of Amguri, Assam, through his Calcutta Agents, Messrs. Begg, Dunlop & Co. The covering letter to Mr. Royle stated that tea planters were anxious to have an auxiliary crop, and asked that a valuation of the sample might be obtained at an early date. The letter concluded by saying that if the report proved encouraging, endeavours would be made to procure a larger parcel so as to allow of a practical test. Also that any suggestions as to

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methods of separation of the fibre, defects of present sample, etc., would be highly appreciated. About the same time the Reporter in a letter to Mr. H. C. Begg of Messrs. Begg, Dunlop & Co., wrote :—I saw the plant growing while I was in Assam. Nothing could be simpler than the system of cultivation and method of separation of the fibre. If the price offered for it should leave a reasonable profit over and above expenses involved, I am disposed to regard this as by far the most promising auxiliary crop which the Assam planters could find. If the Honourable Mr. Buckingham could send me a much larger sample, it would be possible to obtain a definite valuation.

Reply was duly received from Mr. Royle who forwarded the appended reports kindly obtained by him on the sample referred to :—

Reports obtained from experts.

From J. H. CHRISTIE, Esq., *to* J. R. ROYLE, Esq., C.I.E., *Curator, Indian Section, Imperial Institute,—dated 72, Mark Lane, London, E. C., 27th January 1896.*

Yours of 24th and sample of **Sansevieria** to hand. We value £16-17 per ton ; but had colour been bright white instead of yellow, we should have put same £20 per ton. This fibre will sell easily ; we shall be glad to see a trial shipment of 20 or 30 tons. The cleaning is perfect and cannot be improved.

From C. E. COLLYER, Esq., *to* J. R. ROYLE, Esq., C.I.E., *Curator, Indian Section, Imperial Institute,—dated 155, Fenchurch Street, E. C., 23rd January 1896.*

I have examined the sample of fibre described as "Bow-string Hemp," **Sansevieria zeylanica.** This specimen is inferior to the fibre obtained from the usual growths of **Sansevieria zeylanica.** It is less fine, more variable in strength, partly weak and brittle and of poor colour—these defects may possibly be owing to the fibre being overripe or from old stems—as it is it is too much like some of the Aloe fibres to realise its intrinsic value, and in the condition of this specimen it would not in the present low markets realise more than about £20 per ton in London, but when more carefully prepared and of the usual good strength and colour the value would probably be £25 per ton and upwards. A few tons carefully prepared should be sent to test the market.

From C. E. COLLYER, Esq., *to* J. R. ROYLE, Esq., C.I.E., *Curator, Indian Section, Imperial Institute,—dated 155, Fenchurch Street, E. C., 24th January 1896.*

In continuance of my Report on the **Sansevieria zeylanica** fibre, and in reply to your questions of the 21st instant. The quality of the fibre

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Reports obtained from experts.

would be much improved by the use of suitable decorticating machines and so far as any fibre has come to market the best results have been from the improved " W. E. Death" machine which turns out about 6 cwt. per day of cleaned fibre at a cost at least as small as by any other system. Soil and climate have much to do with the quality of the fibre and also to have the right variety for fibre purposes of the **Sansevieria zeylanica.** The fibre may be packed in bales of about 3 cwt. each, moderately pressed; each head (or small bundle) tied round near the butt end with some of the fibre—the fibre must not be knotted or plaited but packed straight, to preserve the fibre from being discoloured; the fibre to be perfectly dry before packing.

From MESSRS. SLANN & DAVIS, *to* J. R. ROYLE, Esq , C.I.E , *Curator, Indian Section, Imperial Institute,—dated 51 and 52, Fenchurch Street, E. C., 29th January 1896.*

In reply to yours of 24th instant (which we regret we have not replied to before) we have examined the sample of fibre you sent us and find this very similar to Aloe fibre, fair colour, good strength. We should value same at about £18 per ton up, we might even get as much as £20, but this is very uncertain in the present state of the market. Prices are at present lower than they have been for many years, but there is every prospect of an improvement before long, as the low prices have stopped the production of certain hemp (New Zealand, etc.) and Manila is very firm now with every prospect of higher prices. Of course it is very difficult to give an exact valuation on the small sample sent us; we would recommend you to get your friends to ship, say, 10 bales when we should be pleased to give the fibre a fair trial.

To procure larger quantity time is necessary.

The Honourable J. Buckingham, C.I.E., through Messrs. Begg, Dunlop & Co., informed the Reporter that he regretted he would not just yet be able to furnish a larger quantity, but that he was extending the cultivation of the fibre as quickly as possible. Mr. Royle was accordingly informed (letter No. 1227—76, dated 29th April 1896,) that some delay might be expected before a large supply of the fibre could be produced. Copies of the correspondence and of the foregoing reports were then handed to Messrs. Begg, Dunlop & Co. by the Reporter with a letter No. 951—76, dated the 2nd April 1896. In that letter the Reporter mentioned that a few tons of the fibre were required as an experimental consignment to test the market, and also for complete investigation by the Research Department of the

Imperial Institute. The Reporter accordingly requested to be informed whether Messrs. Begg, Dunlop & Co. would be prepared to entertain the idea, and added :—"It would seem desirable that you should go the length of purchasing a machine suitable for cleaning the fibre, and one of my correspondents, it will be observed, has suggested the one that is considered most suitable" The Reporter further stated that the Honourable Mr. Buckingham's discovery of the suitability of this fibre plant to the conditions of many of the waste lands of the tea districts was probably one of considerable value. That he had recently been urging to the attention of planters the claims of Rhea fibre for that purpose. There could be no doubt that there was room for both fibres, and that some districts might find the Bow-string Hemp more convenient and equally profitable to Rhea. These were fibres that would meet independent demands, and could never enter into competition. It had been suggested that Sansevieria Roxburghiana might be found a better species than S. zeylanica. Before direct steps were taken to lay out a plantation, experiments might be made on a small scale side by side with authentically named rooted plants of both forms. Very possibly these could be supplied by the Superintendent, Botanic Garden, Sibpur.

MURVA CONSIDERED IN RELATION TO RHEA.

Purchase of a decorticating machine suggested.

Sansevieria Roxburghiana possibly better than S. zeylanica.

The Honourable J. Buckingham, C.I.E., wrote under date 28th April 1896, through Messrs. Begg, Dunlop & Co.: "It is very satisfactory to find the fibre so well spoken of, but it is quite impossible for me as yet to get any large quantity of it. It appears to me that the best thing I can do is to extend the cultivation of this fibre at first to about 5 acres, and then see what that area is capable of producing. I have enough at present (starting from a single plant only) to put out about one acre, and all the available shoots I am now cutting up and planting out.

The following Report on the sample in question was kindly furnished by Sir Frederick Abel, Bart., K.C.B., with Flying Seal letter No. 92, dated 11th June 1896. This Report gives the comparative results of examination of the fibre obtained in the Research Department of the Imperial Institute.

IMPERIAL INSTITUTE.

REPORT ON SANSEVIERIA ZEYLANICA FIBRE.

The fibre of this plant, which belongs to the natural order LILIACEAE is of a beautiful light colour and finegloss. The staple is about four feet in length, of smooth well-formed threads.

SANSEVIERIA zeylanica.

Murva Fibre as a Second or Catch

IMPERIAL INSTITUTE.

Report of the Research Department.

The sample was obtained from Amguri in Assam, where Dr. George Watt, C.I.E., Reporter on Economic Products, observed that it was being grown upon waste land by a tea planter. Dr. Watt states that the plant can be grown without cultivation; if fragments of the leaves are scattered over the soil, each fragment takes root rapidly, and a good crop is yielded in a very short time.

Chemical examination shews this fibre to be of high quality. Mr. Cross (a member of the Committee of Advice) examined a sample of **Sansevieria** which was included in the collection at the Indian and Colonial Exhibition, and also tested its paper-making qualities; the chemical results obtained by him shewed that the specimen he examined was inferior in quality to the present sample. (*Report on Indian Fibres, 1886.*)

The following are the results furnished by the two samples :—

Sansevieria zeylanica.	Assam.	From Colonial and Indian Exhibition.*
Moisture %	9·4	9·7
Ash %	0·7	...
Loss by A. hydrolysis %	11·8	12·
Loss by B. hydrolysis %	14·9	16·5
Loss by mercerising %	11·6	
Loss by acid purification %	1·4	2·5
Gain by nitration %	33·5	6·0
Cellulose %	75·6	64·6
Length of ultimate fibre in mms.	1·5—3·5	1·5—2·5

* (Report on Indian Fibres.)

With the exception of the results of chemical examination obtained in the Scientific Department of the Imperial Institute, there are very few available for purposes of general comparison of monocotyledonous fibres. Reports on twenty-one different species have from time to time been published in the Institute Journal. Many of the fibres dealt with in these reports were obtained, it is true, from plants which were not indigenous to the locality they were grown in. Special care, however, had been taken in the cultivation and treatment, so that the fibre which they furnished was probably little inferior to the same kind of fibre derived from the wild plants grown in their natural habitat. Accepting the results which they furnished as suitable for purposes of general comparison, it appears that the "cellulose" numbers furnished by of fibres monocotyledonous origin range from about 61 to 77, the average number being about 70. The "nitration" numbers range from 9 to 34, with an average of about 20.

Cellulose.

Sansevieria, which furnishes the numbers 75 and 33, respectively, therefore ranks high among these fibres. Again, the A. and B. "hydrolysis" numbers, and especially the difference between them, are of special

Nitration.

IMPERIAL INSTITUTE. Report of the Research Department. Hydrolysis. Victoria-grown fibres compared.

significance. The Victorian monocotyledonous fibres may indeed be classified from this point of view (see Victoria-grown fibres, Imperial Institute Journal). Thus, the approximate A. and B. hydrolysis numbers and the differences are, respectively, for the Cordylines :—15, 19 and 4: for the Agaves :—16, 21 and 5 : for the Kniphofias :—17½, 23 and 6.

Sansevieria furnishes the numbers 12, 15 and 3. These would indicate that it should possess special powers of resistance to weathering and the accompanying hydrolytic effects. The general results of chemical examination of this fibre may be considered as very satisfactory. A comparative statement of the results furnished by the monocotyledonous fibres, showing the relation of Sansevieria thereto, is appended :—

	A. Hydrolysis. No.	B. Hydrolysis. No.	Difference.	Cellulose. No.	Nitration. No.
Cordylines . .	15	19	4	68½	18
Agaves . . .	16	21	5	75½	19
Kniphofias . .	17½	23	6	71	29
General range .	10—18	20—30	10	61—77	9—34
Sansevieria zeylanica	12	15	3	75½	33

The reports of experts on this sample of Sansevieria were favourable, although it exhibited some trifling defects due, probably, to the degree of maturity of the plant from which it was prepared. A supply of several tons has been asked for, with a view to submit it to practical trials.

Note on the Cultivation of Sansevieria zeylanica, *by a West Indian Planter.**

CULTIVATION OF MURVA FIBRE.

The plant grows best in a moderate shade in black soil, the cultivation is *easy* from either cuttings from stems or from roots, the plants should be about 18 inches apart and 18 inches between the rows, the soil should be moist but not too wet, and the growth is much more rapid under shade than in the hot sun and the quality of the fibre is better. The plants are usually ready for cutting in from 9-12 months and may be cut at any season, *except after a long drought*, when the fibre is apt to be harsh and tender. The plants attain nearly double the height in black soil and shade compared with the red soil in the sun, and the fibre of the freely growing plant is naturally much superior.

* Furnished by J. R. Royle, Esq., C.I.E.

G. I. C. P. O.—No. 393 R. & A.—23-12-96.—2,100.—B. N. D.

THE

AGRICULTURAL LEDGER.

1896—No. 31.

CARICA PAPAYA.

(PAPAW OR PAPAYA.)

[*Dictionary of Economic Products, Vol. II.,* C. 581.]

Report on a Sample of the Dried Juice of **Carica Papaya** *from Gondal, Kathiawar, by* MR. JOHN C. UMNEY, *to which is prefixed a Review of the Recent Literature on the Subject by* THE OFFICIATING EDITOR.

REVIEW OF RECENT LITERATURE.

The **Carica Papaya** tree is so well known and established in India that it seems desirable to set forth what authentic information we possess on the remarkable properties of the plant. A vast amount has recently been written on the action of the "vegetable pepsin" contained in the juice that abounds in the unripe fruit, and the present time affords a suitable opportunity for reviewing the literature of subject.

The digestive action of the juice upon meat was probably known in the West Indies at a very early date, and appears to have been communicated to the inhabitants of this country upon the introduction of the tree by the Portuguese, as it has long been the custom in India to render meat tender by rubbing it with the juice of the fruit or by wrapping it in the leaves. In the old "*History of Barbadoes*" by Griffith Hughes, the author quaintly informs us that "this juice is of so penetrating a nature that if the unripe peeled fruit be boiled with the toughest old salted meat, it quickly makes it soft and tender; and if pigs be fed with the fruit, especially unripe, the thin mucous matter which coats the inside of the intestine is attacked, and, if the food be unchanged, is completely destroyed." The author of the *Makhzan-el-adwiya* (*1770*) described the tree in his day, and mentions the use of the juice mixed with ginger, for making meat tender.

In *1877*, the milky juice of the **Carica** began to attract attention in Europe as a digestive ferment, and Herr Wittmack, of Berlin, in 1878

made a careful examination of its properties and came to the following conclusions respecting it:—

(1) The milky juice of the **Carica Papaya** is (or contains) a ferment which has an extraordinarily energetic action upon nitrogenous substances, and like pepsin curdles milk; (2) this juice differs from pepsin in being active without the addition of free acid, probably it contains a small quantity, and further it operates at a higher temperature (about 60° to 65° C.) and in a shorter time (5 minutes at most); (3) the filtered juice differs chemically from pepsin in that it gives no precipitate on boiling and further that it is precipitated by mercuric chloride, iodine, and all the mineral acids; (4) it resembles pepsin in being precipitated by neutral acetate of lead, and not giving a precipitate with sulphate of copper and perchloride of iron (*Pharm. Jour., Nov. 30, 1878*).

Dr. Geissler, experimenting in the same direction, found that papain could dissolve 28 times its weight of coagulated albumen, while pepsin dissolved 100 times its own weight.

In 1879 **Dr. Theodor Peckolt**, of Brazil, made a very complete analysis of the fruit, leaves and seeds of **Carica Papaya**, and he found papayotin in nearly every part of the fresh plant, besides other organic constituents which he separated and estimated.

Dr. Sidney Martin of London was the next to investigate the peculiar principle of the fruit. He showed in 1886 (*Journal of Physiology*) that papain was a protolytic ferment which acts very similarly to trypsin. Experiments performed with meat fibrin and white of egg showed that slight digestion takes place when the liquid is faintly acid, but none at all when decidedly acid. Digestion takes place actively in neutral or alkaline solutions, and occurs most readily at a temperature between 35° and 40° Fahrenheit. The results of the digestion are peptones, leucine and tyrosine and an intermediate globulin-like substance similar to that formed in pancreatic digestion.

In the author's second paper on the same subject the ferment in papaw juice is shown to be associated with an albumose, and to give the following reactions in addition to those previously described by **Wurtz**:—The solution gives a biuret reaction, and it is precipitated from a neutral solution of sodium, magnesium sulphate or sodium chloride alone, as globulins are. It is soluble in glycerol, and if precipitated from this solution by alcohol, the filtrate has no proteolytic power. The kind of albumose is one nearly akin to the protalbumose of **Kühne** and **Chittenden**, and is called α-phytalbumose. Papaw juice also contains a milk-curdling ferment. The proteids present in papaw juice were found to be as follows:—

(1) Globulin, resembling serum globulin in its most important properties.

(2) Albumin.

(3) β-phytalbumose precipitated almost completely by heat, by saturation with neutral salts, but not by dialysis. It differs from the heteroalbumose of Kühne and Chittenden, by not being precipitated by dialysis, by copper sulphate, or by mercuric chloride.

(4) α-phytalbumose; soluble in cold or boiling water; not precipitated by saturation with neutral salts, except in an acid solution. This is the vegetable peptone referred to by Vines (*Journ. Physiol*, iii.) as hemialbumose. It differs from the protalbumose of Kühne and Chittenden by its non-precipitation by sodium chloride or by copper sulphate. Both these albumoses give the biuret reaction.

No peptones occur in the juice, but leucine and tyrosine are present. By a series of digestion experiments carried out on each of these proteids by papain in a neutral liquid, it was found that both the globulin and albumen are changed into β-phytalbumose, and that this becomes a peptone-like substance, and forms leucine and tyrosine. The α-phytalbumose becomes a similar peptone-like substance, leucine and tyrosine being formed. This peptone-like substance, resembles the debuteroalbumose of Kühne and Chittenden, except that a solution of it when rendered acid by acetic acid in the presence of sodium chloride, does not become cloudy on warming. No true peptones are formed. Probably digestion in the plant itself is very slow, as much more liquid was used in the experiments than is present in the juice. The albumose forms probably the circulating proteid in the plant.

The leaves of the Carica which are said to make meat tender when they are wrapped round it for some time, were discovered by Dr. Greshoff in 1891 to possess an alkaloid named carpaine. Dr. Van Rijn further investigated the alkaloid in 1893 but did not attribute to it any digestive property. The quantity of carpaine separated from the leaves was 0·25 per cent.

On the evidence of the medical, physiological and chemical experiments made upon the papaya the active principle has been separated and given the name of papain or papayotin. It is now an article of commerce in Europe for medical purposes: it has been extensively used in France and Germany, and has been given with good results even to children.

Notwithstanding all the experiments on the vegetable ferment in question it seems not to have been received with confidence by the medical profession in England, and it has not been introduced into the Pharmacopœias as a substitute for pepsin. The statement often made that papain dissolves 200 times its own weight of fibrin has been contradicted on more than one occasion, and on the other hand it has

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been shown that papain compares very unfavourably with pepsin when tested with egg albumen under similar conditions.

Regarding this aspect of the case two important papers have recently been written. Dr. S. Rideal of St. George's Hospital, London (*Pharm. Journ.*, August 1894) endeavoured to make out a good case for papain, and attributed unfavourable results to the mistake of supposing that papain should be tested under the same conditions that hold good for pepsin. Dr. Rideal noticed that papain differs from pepsin in so far as the former acts fairly well in an alkaline solution, while the latter does not, and more particularly that the proportion of fluid to albumen must be much less in the case of papain than is required with pepsin. Mr. D. B. Dott, F.I.C., in the more recent article (*Pharm. Journ.*, March 7, 1896) records some experiments from which he adduced the following conclusions:—

1. That dried papain juice, and the papain prepared from it by purification and precipitation have very little solvent action on albumen, either in alkaline or acid solution.

2. That commercial papain has not nearly the solvent action on albumen which is possessed by pepsin, although it has a disintegrating and special action of its own on animal tissues.

During the course of Mr. Dott's investigations the presence of pepsin was suspected in one of the samples of commercial papain.

The next question that seems desirable to settle is the preparation of commercial papain. If, as it has been suggested, the papain is liable to sophistication with pepsin or other subtances, it is impossible to arrive at any satisfactory results with regard to its digestive action. Then, again, the preparation in this country of the juice for the market has not perhaps received a sufficient amount of attention. It should be known that the juice in every case must be collected from *unripe* fruits. As prolonged moisture is deleterious to the ferment, the juice should be dried as soon as possible, and, as heat will destroy its activity, it should be dried at a low temperature. The best method to prepare papain is to collect the juice of the unripe fruit, mix the juice with twice its own volume of rectified spirit, let the mixture stand for a few hours, and then filter off the insoluble matter, and dry it at the ordinary temperature of the atmosphere. After being powdered it should be kept in well-stoppered bottles ready for use.

The following notes on the collection of specimens of papain in India by the Reporter on Economic Products Office and the results of their examination in London will be read with interest. They show what varied activity the samples may possess if not carefully collected and preserved. If a trade in this substance is to be expected either in

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India or in Europe we would impress upon all manufacturers to observe carefully the precautions just enumerated. On account of caste difficulties, it would be impossible to introduce pepsin very largely into use in this country, but where a vegetable substitute is available every effort should be made to increase our knowledge of it and to understand its action and methods of manufacture and administration.

In May 1894, Mr. M. J. Bharwada, Agricultural Assistant, Gondal, Kathiawar, forwarded to the Reporter on Economic Products three samples of papain obtained from the juice of the fruit ot the Papaw tree. These were (1) the precipitate from the milky juice made by adding pure alcohol; (2) the precipitate from the same juice by addition of rectified spirit; and (3) the dried and powdered juice. The specimens were forwarded to Mr. E. M. Holmes, Curator of Museum of the Pharmaceutical Society, who was asked to have them tested and reported upon with reference to their comparative value as substitutes for pepsine. Mr. Ernest J. Easters, F.I.C., was kind enough to examine them, but he stated that they arrived in such a bad condition that not one of the samples was found to have any disturbing action on milk; the curdling of milk is a very characteristic property of the ferment of papaya juice.

Subsequently Mr. Bharwada made a second collection of products of Carica for examination, consisting of twelve ounces of the dried powder obtained from the juice, and a small quantity of papain prepared with alcohol. These were forwarded to the Curator of the Pharmaceutical Society who kindly placed them in the hands of Mr. J. C. Umney, F.C.S., for investigation. In reproducing Mr. Umney's report on the samples, the Editor takes this opportunity of thanking this gentleman for his valuable assistance in again undertaking the examination of an Indian product. From Mr. Umney's experiments it would seem that a highly active ferment might be manufactured from the crude juice by repeated purification by alcohol. The attention of all those who are interested in the subject should be drawn to this method of preparation.

Report on a Sample of Powder of the Dried Juice of Carica Papaya, *from Gondal, Kathiawar.*

MR. UMNEY'S REPORT.

The sample was in coarse powder, of a greyish yellow colour, and possessed a faint, somewhat unpleasant, odour.

Ten grammes dissolved in water and precipitated by absolute alcohol yielded 4·2 grammes of crude Papain, after drying at ordinary temperature over sulphuric acid.

The digestive power of this purified product was then tested on moist egg albumen, at a temperature of 38°—39° C. in neutral acid and alkaline

CARICA Papaya.

Report on a Sample of the Dried Juice of Carica Papaya.

MR. UMNEY'S REPORT.

solutions using the following proportions :—

10	grammes of	egg albumen,
0·1	,,	of papain.
30	c. c.	Distilled water.
0·1	grammes	Bicarbonate of Sodium for alkaline.
1	c. c.	Hydrochloric acid B. P. for acid.

Digested in 30 minutes.

Neutral . .	12·03 per cent.
Alkaline . .	13·72 ,, ,,
Acid . .	12·07 ,, ,,

These results indicate that the digestive activity in neutral and acid solutions is almost identical, whilst in alkaline solutions it is somewhat greater.

These results were compared with a well known commercial Papain, proceeding on exactly similar lines, the results obtained being as under :—

Digested in 30 minutes.

Neutral . .	17·81.
Alkaline . .	17·483.
Acid . .	25·0.

The greater activity in acid than neutral and alkaline solution is the principal point of difference between this brand of Papain and other commercial samples of papains and concentrated papaw juice, and has been the subject of controversy between different experimenters. The presence of another ferment, such as pepsin, active in acid solution, appears to be indicated.

I have examined several samples of commercial papains, and the results have been similar in every respect, and it may be noted that they accord well with those obtained by Dott (*P. J.*, 3rd Series, xxiv, 758, 759).

There is no doubt that by repeated precipitation by alcohol a highly active digestive product might be obtained from this crude concentrated papaw juice valuable for use under those circumstances where pepsin is unavailable.

JOHN C. UMNEY.

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(Medicinal Products.)

THE
AGRICULTURAL LEDGER.

1896—No. 32.

ACONITUM HETEROPHYLLUM.

(ATIS.)

[*Dictionary of Economic Products, Vol. I,* A. 401.]

REPORT ON THE CONSTITUENTS OF ACONITUM HETEROPHYLLUM.

By PROFESSOR WYNDHAM R. DUNSTAN, *Director of the Scientific Department of the Imperial Institute. To which is added a Thesis on* **Atisine,** *the* **Alkaloid** *of* **Aconitum heterophyllum,** *by* H. A. D. JOWETT, D.Sc.

PREFATORY REMARKS BY THE EDITOR.

The subject of *Atis* as a drug to be used in malarial fever attracted considerable attention in the earlier years of European medicinal practice in India. It was investigated by practical men for many years, with the result that while it was assigned a recognised position as a useful tonic medicine it was refused altogether any claim to its reputation in Native pharmacy as an antiperiodic. At the same time the chemical and physiological properties of the drug were but indifferently inquired into, and in consequence a large number of persons continued (and still continue) to speak of it as a drug that possesses high merit, though its peculiar properties had been neglected, or at all events not sufficiently investigated.

In this view of the case, therefore, it was with considerable satisfaction that the opportunity offered by the Research Department of the Imperial Institute was embraced to have any doubt that might still exist removed. Large collections of the root were made at

certain selected centres through the agency of this office. These were in due course forwarded to London, and India is to be congratulated in having secured for this inquiry the services of two of the most skilled investigators in Europe,—Professor Dunstan and Dr. Jowett.

Professor Dunstan's Report will be seen to practically confirm the view medical men in India have taken, and Dr. Jowett's investigations are of so high an order and so exhaustive that it may now be readily admitted that *Atis* has been raised from a position of scientific obscurity to being one of the most carefully and thoroughly investigated drugs in the field of Indian Materia Medica.

The value of these researches have even a wider bearing than that of solving the difficulties of *Atis*. They will be found to have a distinct bearing on the chemistry of the genus Aconitum. And when it is added that large supplies of the roots of all the other species of that genus have been supplied and are at the present moment on their way to London, it will be seen that at no very distant date the present report will be followed up by others of perhaps even greater interest because dealing with drugs of greater value to India.

From SIR FREDERICK A. ABEL, BART., K.C.B., F.R.S., *Secretary and Director, Imperial Institute, London, to* GEORGE WATT, ESQ., M.B., C.M., C.I.E., ETC., *Reporter on Economic Products to the Government of India, Indian Museum, Calcutta,—No. R.$\frac{119}{1}$ (F. S. S. No. 95), dated London, the 28th July 1896.*

I have the honour to forward herewith, for the information of your Department, a Report made to me by Professor Dunstan, the Director of our Scientific Department, on the subject of Aconitum heterophyllum.

The investigation of this substance has been so far carried on under Professor Dunstan's direction in the Research Department of the Pharmaceutical Society, but the further examination of the other varieties of Aconite species, which have been supplied by the Indian Government, will be carried on in the Scientific Department here.

It will be seen from the Report of Professor Dunstan that the results arrived at in the Research carried out by Dr. Jowett under his direction, although scientifically interesting, do not afford very great promise of this particular plant possessing therapeutic value, although this point will be more satisfactorily determined when opportunity has presented itself of testing the therapeutic value of the

pure alkaloid which has been separated from the **Aconitum heterophyllum.**

The Report is accompanied by the full account of this alkaloid, published by Dr. Jowett.

From GEORGE WATT, ESQ., M.B., C.M., C.I.E., etc., *to* SIR FREDERICK A. ABEL, BART., K.C.B., F.R.S, *Secretary and Director, Imperial Institute, London, No. 2520 F. S., dated Calcutta, the 18th August 1886.*

I am directed to acknowledge your No. R. $\frac{313}{1}$ (F.S S. No. 95), dated the 28th July, as also Professor Dunstan's Report on **Aconitum heterophyllum,** and Dr. Jowett's very learned and able researches into the chemistry of that Aconite. It has been decided to publish these papers in The Agricultural Ledger, a copy of which is presented to every medical man throughout India. In this way full publicity will be given to the investigations. I may perhaps say that as a Member of the Indigenous Drugs Committee I was present at a meeting recently held when *Atis* (**Aconitum heterophyllum**) after a careful consideration of the evidence on the subject was relegated to the position of a mild tonic, but refused continuance of its former place as an antiperiodic. This view is thus in full accord with Professor Dunstan's and Dr. Jowett's researches, but the further therapeutic investigations that it is proposed to conduct will be looked forward to doubtless with much interest by the profession in India. The authoritative disposal of this medicine or rather its assignment to its true place in Indian Pharmacy will be a subject for which a debt of gratitude will be due to yourself and the skilled investigators of the Research Department of the Institute.

IMPERIAL INSTITUTE.

Report by the Director of the Scientific Department on

Aconitum heterophyllum.

A very thorough examination of the constituents of **Aconitum heterophyllum,** supplied from the India Collections of the Imperial Institute, has been conducted under my supervision by Dr. H. A. D. Jowett.

The principal alkaloid was partially described by Broughton in 1873 and named by him "atisine". The formula assigned by Broughton to this alkaloid was $C_{46}H_{74}N_2O_5$. In 1879 Wasowicz

ACONITUM heterophyllum. On Atisine, the Alkaloid of

confirmed and extended Broughton's results, but shortly afterwards Alder Wright stated that atisine should be represented by the formula $C_{22} H_{39} NO_2$. It was with the view of settling the question of the composition and characteristics of this alkaloid and of comparing its chemical relationships and properties with those of the alkaloids derived from other species of aconite that the present enquiry was undertaken. The results of the investigation, which will shortly be published in the " Journal of the Chemical Society ", may be summarised as follows.

Atisine is an uncrystallisable base represented by the formula $C_{22}H_{31}NO_2$. It is laevo-rotatory and furnishes crystalline salts, several of which have been prepared and their properties described. The alkaloid is non-poisonous in small doses and therefore differs from the chief alkaloids of the other principal species of **Aconitum**, *viz.*, **Aconitum Napellus, A. ferox** and **A. japonicum,** and it is clear from the behaviour of atisine towards chemical reagents that its chemical structure is very different from that of these other Aconite alkaloids,—all of which, I may add, are at present being investigated and compared by me and my assistants. In future this enquiry will be conducted in the Research Laboratories of the Imperial Institute. The reports hitherto received from India as to the medicinal effects of **A. heterophyllum,** do not furnish much ground for hope that this plant will prove of great value. I intend, however, to have therapeutic experiments made with the pure alkaloid atisine as soon as the fresh consignment of roots, now on its way, has been received from India, and a further supply of this alkaloid has been extracted from them. The results of Dr. Jowett's investigation of the constituents of this plant have formed the subject of a thesis presented by him to the University of London, which has gained for him the Degree of Doctor of Science. A copy of this thesis is sent herewith.

WYNDHAM R. DUNSTAN.

July 25th, 1896.

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ON ATISINE,

The Alkaloid of Aconitum heterophyllum.

BY H. A. D. JOWETT, D.SC.

INTRODUCTORY.

This paper deals with an investigation of the alkaloid contained in the roots of a species of Aconite—**Aconitum heterophyllum**, *Wall.*,—a species especially interesting on account of its non-toxic character.

A very brief account is first given of the present state of our knowledge of the alkaloids of the different species of Aconites, which have, so far, been investigated, followed by a *resumé* of the work of Broughton and Wasowicz on the chemical constituents of **Aconitum heterophyllum.**

The account of this experimental work then commences with a description of the method employed in the extraction of the alkaloid from the roots, and the preparation of the pure salts of the contained alkaloid—Atisine—on the large scale. The existence of aconitic acid in the root, as stated by Wasowioz, is confirmed by the isolation and identification of this acid. The properties and physical constants of atisine and the following salts—hydrochloride, hydrobromide, hydriodide, nitrate, aurichloride and platinichloride—are then described and a formula ($C_{22}H_{31}NO_2$) for the alkaloid proposed, based on the results of analyses of pure material.

Finally, the action of certain chemical reagents upon this alkaloid has been studied with the object of obtaining some clue as to its constitution. Caustic alkalies or mineral acids do not break down the molecule of atisine, but result in the addition of the elements of water, a new base—Atisine monohydrate—being formed, whose salts, however, could not be obtained in the crystalline condition.

By treatment with fuming hydriodic acid no methyl iodide was formed, thus proving the absence of methoxyl groups in the molecule. A preliminary experiment, performed by heating atisine hydriodide with soda lime, showed that a volatile substance of a phenolic nature is formed under these conditions.

It is intended to continue the experiments on the constitution of the alkaloid when a further supply of the root is obtained.

PART I. HISTORICAL.

THE ALKALOIDS OF THE ACONITES.

Of the many (about 180) species of the genus **Aconitum** known to botanists, only a few have been examined with regard to their chemical constituents, and these are the species **Napellus, ferox, japonicum, Lycoctonum** and **heterophyllum,** all of which possess poisonous properties, with the exception of the **heterophyllum.**

Great difficulties have been encountered in the investigation of the Aconite alkaloids, and at present only those of one species—**Napellus**—can

be said to have been thoroughly investigated. In addition to the difficulty of obtaining selected roots, whose authenticity is beyond question, most of these alkaloids very readily undergo decomposition, and it is thus difficult to obtain them in a pure and crystalline condition. Considerable confusion has arisen since non-homogeneous mixtures of alkaloids (often of amorphous bases) have been described as pure substances, and named accordingly, and thus from the same plant a considerable number of alkaloids have been supposed to have been isolated.

A great deal of work was done on this subject by Wright and Luff, but these chemists did not complete the work, which has since been revised and extended by Dunstan and *collaborateurs*. A short account will be given of the state of our knowledge of each of the above species.

Aconitum Napellus.

This plant has been the subject of much research, Geiger and Hesse[1] as far back as 1833 isolating an alkaloid from the root, to which they gave the name *Aconitine*.

The reactions and constitution of this alkaloid have been very carefully studied, and much of the contradictory matter cleared away by the work of Wright and Luff,[2] and subsequently of Dunstan and *collaborateurs*,[3] whose chief results are given below.

Aconitine is a crystalline alkaloid (yielding crystalline salts) of the probable formula $C_{33}H_{45}NO_{12}$, and is acetyl-benzoyl-aconine $[C_{24}H_{37}\cdot(CH_3\cdot CO)\cdot(C_6H_5\cdot CO)NO_{10}$, yielding by hydrolysis, first, benzoyl-aconine and acetic acid, which was at first overlooked, and on further hydrolysis, benzoic acid and aconine. Both benzoyl-aconine and aconine are amorphous bases, yielding, however, crystalline salts. By heating aconitine, there is formed acetic acid and a new crystalline base—Pyraconitine—which, by hydrolysis, yields benzoic acid and pyraconine. Pyraconitine and pyraconine are thus the corresponding anhydro-derivatives of benzoyl-aconine and aconine respectively, anhydro-aconitine itself having been obtained by dehydrating aconitine under certain conditions.

Aconine may thus be considered the parent substance of this group of alkaloids, from which are derived two series—the anhydrobases of the benzoyl and acetyl-benzoyal derivatives of aconine—and the bases themselves, in addition to which a large number of synthetical products as (n-acetyl)-benzoylaconine, etc., have been prepared, although aconitine itself has not yet been synthesised. Beyond the fact that aconine contains four methoxyl[4] groups nothing is known about its constitution.

Aconitum ferox.

Our knowledge of the alkaloids of this species is due to the work of Wright and Luff,[5] though Dunstan[6] has taken up the work recently, and a preliminary note on the subject has been published. The roots contain a crystalline alkaloid with analogies to, but not identical with, aconitine, which Wright named *Pseudaconitine*, of the formula $C_{36}H_{49}NO_{12}$: it readily undergoes hydrolysis, yielding acetic acid (discovered by Dunstan

and overlooked by Wright), veratric acid (dimethoxybenzoic acid, 1 : 3 : 4 $COOH : OCH_3 : OCH_3$) and pseudaconine, and is thus acetyl-veratryl-pseudaconine.

$$[C_{25}H_{37}\cdot(CH_3CO)\cdot C_6H_3(OCH_3)_2CO)NO_8].$$

The intermediate base, veratryl-pseudaconine, analogous to benzoyl-aconine, has been isolated, and is still under examination. Anhydro-pseudaconitine and anhydro-pseudaconine have been prepared and described, but not anhydro-veratryl-pseudaconine. Anhydro-pseudaconitine yields a monoacetyl-and monobenzoyl-derivative, and thus pseudaconitine probably contains three hydroxyl groups.

Mandelin[7] asserts that pseudaconine is identical with aconine, but this statement requires confirmation. Pseudaconine may thus be regarded as the parent substance of this group of alkaloids, as aconine is of the alkaloids of *Napellus*, and from it are derived anhydro-pseudaconitine, the anhydro-base, and pseudaconitine, the acetyl-veratryl derivative.

Aconitum japonicum.

The alkaloids of this species were examined by Wright and Luff,[8] who isolated from the root a crystalline alkaloid, which they named *Japaconitine*, and to which they ascribed the formula $C_{66}H_{88}NO_{21}$; this on hydrolysis yielded benzoic acid and japaconine ($C_{26}H_{41}N_2O_{10}$). According to this view, japaconitine itself is the condensation product formed from two molecules of a hypothetical substance of the formula $C_{33}H_{47}NO_{12}$, by the elimination of three molecular proportions of water. No anhydro-derivatives of this series have been prepared, and this formula clearly requires confirmation.

Mandelin[9] has stated that japaconitine and japaconine are identical with aconitine and aconine respectively.

Lubbe[10] has prepared the crystalline alkaloid, and concludes that japaconitine is identical with aconitine, basing his conclusion on the following facts :—(i) the analytical results of the contained carbon, hydrogen, and nitrogen agree exactly with those calculated for aconitine; (ii) the molecular weight as determined by the depression of the freezing point of benzene is identical with that of aconitine; (iii) both crystalline japaconitine and aconitine melt at the same temperature; (iv) the specific rotatory powers of japaconitine hydrochloride and aconitine hydrochloride, as determined by Jurgens,[11] are identical.

His results certainly prove that Wright's formula cannot be accepted for japaconitine, the calculated molecular weight being 1244, whilst Lubbe found 672, so japaconitine has not the constitution as stated by Wright. On the other hand, Lubbe's work does not prove the identity of japaconitine with aconitine, for in this case analytical results are of little value, since a small difference in composition—a case to be expected—would remain undetected by analytical methods. The best evidence

is afforded by the physical constants of the pure base and its salts, and, in this case, Lubbe's japaconitine melted at 183°—184°, whilst aconitine melts at 190°; it was inactive towards polarised light, but Dunstan and Inoe found that the specific rotation of aconitine was + 11·01[1].

Lubbe's analyses pointed to the formula $C_{83}H_{41}NO_{12}$, and all his results lead us to the conclusion that japaconitine is closely allied to aconitine and pseudaconitine. Benzoyl-derivatives of japaconine have been formed synthetically.

Since japaconitine yields benzoic acid and japaconine on hydrolysis, it should be represented as benzoyl-japaconine ($C_{26}H_{30}$·(C_6H_5CO) NO_{11}); this hydrolysis, however, requires re-investigation, since both aconitine and pseudaconitine have been found to yield acetic acid, and careful search should thus be made for a volatile acid. If this were the case, then the three alkaloids, aconitine, pseudaconitine, and japaconitine, would show a very close analogy to one another.

Aconitum Lycoctonum.

Our knowledge of the alkaloids of this species is both incomplete and unsatisfactory. In 1865 Hübschmann[12] isolated two alkaloids from the root, which he named *acolyctine* and *lycoctonine*, the former of which was assumed to be identical with pseudaconitine or napeline (nepalline) as it was then called, and as such is referred to by various subsequent investigators. Wright and Luff[13] suggested that acolyctine and lycoctonine were identical with aconine and pseudaconine respectively.

Dragendorff,[14] however, showed that the bases of Hübschmann[12] were really decomposition products of the true alkaloidal constituents of the roots, from which he isolated two toxic amorphous alkaloids—*lycaconitine* ($C_{28}H_{34}N_2O_6$ ·$2H_2O$) and *myoctonine* ($C_{27}H_{30}N_2O_8$·$5H_2O$), and to these the toxic effects of the root are due.

On treatment with hot water or hydrochloric acid, lycaconitine undergoes decomposition, yielding lycoctonic acid ($C_{17}H_{18}N_2O_7$), lycaconine ($C_{28}H_{16}N_4O_8$), and acolyctine, identical with the base obtained by Hübschmann; whilst with sodium hydroxide it yields lycoctonic acid, lycoctonine [$(C_{27}H_{47}N_2O_7)_2$·$3H_2O$], acolyctine, and another substance—probably a dioxybenzoic acid.

Myoctonine on treatment with alkali yields the same products as lycaconitine, hence there must be a close similarity between these two alkaloids. It was proved that acolyctine and lycoctonine were not identical with aconine or pseudaconine.

Aconitum heterophyllum.

Only one alkaloid—*Atisine*—has been discovered in this species, and for it Broughton[15] has proposed the formula $C_{46}H_{74}N_2O_5$. It is non-toxic but bitter, but no experiments seem to have been made as to its reaction with alkalies.

The relationship of the different alkaloids contained in three species of Aconitum described is shown in the following table :—

Aconitum Napellus.

Aconitine *acetylbenzoylaconine* $C_{33}H_{45}NO_{12}$	Benzaconine *benzoylaconine* $C_{31}H_{43}NO_{11}$	ACONINE $C_{24}H_{39}NO_{10}$
Apo-aconitine *anhydro-aconitine* $C_{33}H_{43}NO_{11}$	Pyraconitine *anhydrobenzoylaconine* $C_{31}H_{41}NO_{10}$	Pyraconine *anhydroaconine* $C_{24}H_{37}NO_{9}$

Aconitum ferox.

Pseudaconitine *acetylveratrylpseudaconine* $C_{36}H_{49}NO_{12}$	*veratrylpseudaconine* $C_{34}H_{47}NO_{11}$	PSEUDACONINE $C_{25}H_{39}NO_{8}$
Apopseudaconitine *anhydro-pseudaconitine* $C_{36}H_{47}NO_{11}$	?	Apopseudaconine *anhydropseudaconine* $C_{25}H_{37}NO_{7}$

Aconitum japonicum.

?	Japaconitine *benzoyljapaconine* $C_{33}H_{44}NO_{12}$	JAPACONINE $C_{26}H_{40}NO_{11}$

Whilst there seems thus to be a more or less close relationship established amongst the four aconitines, both in their formulæ and their derivation from an aconine, no information is at hand as to the possibility of the identity of atisine—the non-toxic alkaloid—with any of the aconines; in fact, if Broughton's formula be accepted, it would appear to possess a more complicated molecule than any of them. It seems probable that an investigation into the relationship between these aconines could hardly fail to throw considerable light on the whole question of the aconite alkaloids, and when the relationship of the different aconitines to their corresponding aconines is definitely established, it is to be hoped that this investigation will be commenced.

ACONITUM HETEROPHYLLUM.

The roots of this plant, which grows in the West Temperate Himalayas, and other Alpine and sub-Alpine regions of Northern India, are sold in the Indian bazaars as *atis* or *atees*, and are largely used for consumption as a vegetable or mild tonic. It is pleasantly bitter, and

non-toxic, and is regarded as a valuable mild antiperiodic, aphrodisiac, and tonic, checking diarrhœa.[16] It has been long used in India on account of its medicinal value, but very little is known concerning the chemical constituents of the root.

In 1873 Broughton[15] isolated an alkaloid from the roots of this plant, to which he gave the name atisine, and proposed for it the formula $C_{46}H_{74}N_2O_5$. The roots were exhausted with hot alcohol, and the extract, obtained by removal of the alcohol, dissolved in water. The aqueous solution was next rendered alkaline with sodium hydroxide, and extracted with chloroform, which was then removed by distillation. The alkaloidal residue, after solution in dilute sulphuric acid, was decolourised by shaking with animal charcoal, and from this solution the alkaloid was obtained by the addition of potassium hydroxide, when it separated as a bulky white precipitate, which was purified by solution in ether, removal of the ether by distillation, and dissolving the residue in dilute hydrochloric acid. The solution of the hydrochloride thus obtained was rendered alkaline by the addition of dilute aqueous ammonia, and the precipitated alkaloid collected and dried.

The base, which melted completely at 85°, and like quinine is di-acid, was not obtained in the crystalline form, was soluble to a considerable extent in water, carbon bisulphide, and benzene, and formed a bulky hydrate, from which water separated at " steam heat. "

The platinum salt was prepared by adding an aqueous solution of platinic chloride to a solution of the base in dilute hydrochloric acid. From analyses of this salt, which, however, were not recorded, the formula $C_{46}H_{74}N_2O_5$ for the base was deduced, which was confirmed by the amount of hydrochloric acid required to neutralise a known weight of the base. The sulphate and chloride were the only salts prepared in the crystalline condition, and no further details of this investigation have been published.

In 1879, Wasowicz[17] published a paper giving a detailed account of the pharmacognosy and histology of the root, and some account of its chemical constituents. Using a similar method of extraction to that employed by Broughton, he found the roots to contain (i) a fat of soft consistence, probably a mixture of oleic, palmitic, and stearic glycerides; (ii) aconitic acid; (iii) an acid related to ordinary tannic acid; (iv) cane sugar; (v) vegetable mucilage; (vi) pectous substance; (vii) atisine, the alkaloid already observed by Broughton, and probably another uncrystallisable alkaloid; (viii) starch.

The aconitic acid was prepared by adding an aqueous solution of lead acetate to the aqueous extract obtained by dissolving the alcoholic residue in water, collecting the precipitated lead salt, and, after well washing, decomposing it by hydrogen sulphide. After removing the lead sulphide by filtration, the aqueous solution of the acid was shaken with ether, the ether removed by distillation, and the yellow crystalline residue dissolved

in water, shaken with animal charcoal till decolourised, and the aqueous solution then set aside to crystallise, when an almost colourless crystalline mass was obtained, very acid, bitter, and odourless, which melted with decomposition at 165°. After further purification from ether, the acid was analysed, and gave the following results :—

	Found.	Calc. for aconitic acid.
Carbon . . .	41·22 per cent.	41·38 per cent.
Hydrogen . .	3·62 ,,	3·45 ,,

The alkaloid itself was prepared by extracting with ether the filtrate from the precipitated lead salt, after removing the excess of lead acetate by hydrogen sulphide, and was purified by decolourisation with animal charcoal : after removing the ether by distillation, a white amorphous mass was obtained, which, however, on exposure to air and light decomposed and became dark brown. The base did not crystallise from benzole, chloroform, carbon bisulphide, dilute or absolute alcohol. On analysis the following results were obtained :—

	Found.	Calc. for $C_{46}H_{74}N_2O_4$.
Carbon . .	76·75 per cent.	76·88 per cent.
Hydrogen . .	10·66 ,,	10·30 ,,

The base dissolved freely in dilute alcohol, ether, benzene, but only slightly in water, and suffered decomposition by heating on a water bath. Only the hydrochloride hydrobromide, and hydriodide were obtained crystalline ; the nitrate, sulphate, and acetate being obtained amorphous. The hydriodide was prepared by adding potassio-mercuric iodide to a solution of a salt of atisine, washing the precipitate thus obtained, suspending it in water and decomposing by hydrogen sulphide, when, in addition to the mercuric sulphide, pearly crystals of atisine hydriodide separated. These are dissolved in boiling water, separated from the mercuric sulphide by filtration, and, on cooling, the pearly crystals are deposited. The mother liquor deposited crystals on cooling but at a certain point, when crystals were no longer formed and the presence of iodine could not be detected, there was still alkaloid in solution, since a precipitate was obtained on the addition of Mayer's reagent or phosphotungstic acid ; from this it was concluded that the root examined contained a second alkaloid, yielding an amorphous hydriodide.

The crystalline hydriodide was purified by recrystallisation, and dissolved in 318 parts of water at 20°, in 420 parts of 96 per cent. alcohol, but very slightly soluble ir alcohol. Analyses led to the formula $C_{46}H_{74}N_2O_4 \cdot HI + H_2O$; the hydrobromide and hydrochloride having a similar constitution.

In 1879, Dr. C. Alder Wright[38] read a short note before the British Pharmaceutical Conference, in which he proposed for atisine the formula

$C_{22}H_{31}NO_2$ based on a single analysis of the amorphous aurichloride, which gave the following results :—

	Found.	Calc. for $C_{22}H_{31}NO_2 \cdot HAuCl_4$.
Carbon . .	38·04 per cent.	38·82 per cent.
Hydrogen . .	5·09 "	4·70 "
Nitrogen . .	1·93 ; 2·17 "	2·05 "
Gold . .	28·72 "	28·82 "

The work done by previous chemists on atisine is thus both contradictory and incomplete, and in the present investigation it was endeavoured to make our knowledge of the alkaloid of *heterophyllum* both satisfactory and complete.

PART II.—EXPERIMENTAL.

The Extraction of the Alkaloid from the Root and the Preparation of pure Material.

The solvents, previously used to extract the alkaloidal salts from the aconite roots, have been chiefly alcohol, acidified with 1 per cent. tartaric acid, or more recently amyl alcohol (steam-distilled fusel oil).

Experiments were made on the extraction of the roots of heterophyllum using petroleum ether, alcohol, alcohol containing 1 per cent. of tartaric acid, and fusel oil, but none of these solvents were found satisfactory.

The powdered roots, moistened and mixed intimately with lime, and then dried, gave, when extracted by percolation with petroleum ether, an extract, which, on evaporation, was found to contain no alkaloidal substance.

Alcohol or acidulated alcohol was found to exhaust the root quickly, but it extracted such a large quantity of colouring matter, resinous substance, fat, etc., in addition to the alkaloid, that it was found exceedingly difficult to purify the alkaloid from these attendant impurities. In addition the alcohol has to be totally removed by distillation, and the residue then extracted by acidulated water, a process much more difficult to carry out and yielding less satisfactory results, than the shaking-out method used in the case of amyl alcohol, chloroform, or ether.

Amyl alcohol, though not extracting so much colouring matter, was found to act so slowly that the bulk of the percolate obtained was quite unmanageable, and the time taken in completely extracting a quantity of the root rendered the use of this solvent unsatisfactory.

Finally, after a number of experiments with different solvents had been made, it was found that the most satisfactory results were obtained by using a mixture of methyl and amyl alcohol, in the proportion of three volumes of methyl alcohol to one volume of amyl alcohol, the commercial wood spirit and fusel oil being employed for this purpose. The advantages of this solvent for the extraction of the roots are (i) the roots are completely extracted in a very short time and the percolate does not contain very much colouring matter, resin, etc., though more than

if amyl alcohol alone were used; (ii) the percolate can be reduced to a low bulk without very much heating, as the methyl alcohol can be distilled from the percolate *in vacuo* at a low temperature, thus preventing decomposition of the alkaloid by heat; (iii) the alcoholic solution thus obtained (after distillation) deposits a large quantity of fat and colouring matter, from which the alcohol containing the alkaloid in solution can be separated by decantation. The alkaloid can then be extracted by shaking the alcoholic solution with one per cent. aqueous sulphuric acid, and following the methods described when amyl alcohol alone is used. This solvent, which has since been successfully employed for the extraction of other species of aconite roots, possesses the advantages of both methyl and amyl alcohol with none of their attendant disadvantages.

About 60 pounds of the roots in fine powder were extracted by percolation with a mixture of three volumes of wood spirit (methyl alcohol) to one volume of fusel oil (amyl alcohol), and the percolate obtained, which was of a dark brown colour, was distilled over a water bath, when most of the methyl alcohol together with a little amyl alcohol was removed. On standing, the alcoholic solution deposited a large quantity of very dark coloured fat, which was separated by decanting the clear liquid from the sediment.

The alcoholic solution was then repeatedly shaken with one per cent. aqueous sulphuric acid till no more alkaloid was extracted, the acid liquid shaken twice with chloroform to remove amyl alcohol, and the solution, after neutralisation, concentrated by evaporation on a water bath.

The concentrated solution, which was a dark coloured liquid, was rendered alkaline by aqueous sodium hydroxide, and then repeatedly shaken with ether or chloroform till no appreciable amount of alkaloid was further extracted. It is not possible, however, by this method to extract the whole of the alkaloid from the aqueous liquid.

The ethereal (or chloroformic) solution is washed once or twice with water and then distilled, and the residue dissolved in dilute sulphuric acid, using as small an excess as possible. The liquid thus obtained is dark brown in colour, and still contains, in addition to the alkaloidal salt a large quantity of resinous and colouring matter, and this prevents crystallisation when the solution is evaporated.

These attendant impurities are best removed by fractional precipitation of the alkaloid with aqueous sodium hydroxide, the early fractions containing nearly the whole of the impurities, whilst the later fractions consist of almost pure alkaloid. This fractionation is repeated several times till the acid solution of the alkaloid is colourless. The freshly precipitated alkaloid is then, after filtration and washing, suspended in water and dissolved in exactly the right quantity of dilute hydrochloric acid, so that a neutral solution is obtained, and the solution of atisine hydrochloride is then slowly evaporated on a water bath, when crystals separate on concentration. These are filtered off and re-crystallised once or twice from water, and finally from alcohol and ether, by solution in

alcohol and then adding ether till there is a faint permanent turbidity, and setting aside in a stoppered bottle. Fine needle-shaped crystals of the pure hydrochloride are thus obtained, which are collected and dried in the usual manner.

For the extraction of the remaining traces of alkaloid in the different filtrates obtained during fractionation and in the mother liquor after extraction with ether, a different method is employed.

The solution is rendered faintly acid, and then excess of potassio-mercuric iodide (Mayer's re-agent) added. The precipitate is then thoroughly washed by decantation with water several times, and the precipitate suspended in water and decomposed by passing hydrogen sulphide through the mixture until the whole of the precipitate is decomposed. The mixture is filtered and the precipitate extracted by boiling water till no more is dissolved, and the aqueous extracts then mixed and allowed to cool. On standing, very faintly coloured crystals of atisine hydriodide separate, which may be purified by recrystallisation from hot water.

A few crystals can be obtained by concentrating the original filtrate, but owing to the sparing solubility of the salt in cold water nearly the whole is obtained as above. Thus, the whole of the alkaloid is obtained as the crystalline hydrochloride—a salt freely soluble in water—and the hydriodide, which is sparingly soluble in water. The amount of hydriodide contained in the mother liquor is so small that it may be neglected

The amount of alkaloid contained in the root is small, and a rough experiment showed that the amount of contained alkaloid is from 0·2 to 0·3 per cent., the total yield from the 60 pounds being thus about two ounces of pure hydriodide.

No evidence was obtained during these experiments of the existence of any alkaloid other than atisine.

The Preparation and Identification of Aconitic Acid from the Root.

Since the melting point of the acid obtained by Wasowicz did not agree with that recorded for aconitic acid by other observers, the acid was prepared from the root and its properties examined.

The acid was isolated by a method similar to that adopted by Wasowicz, described in Part I., by means of its lead salt and subsequent decomposition by hydrogen sulphide. It was purified by crystallisation from water till the melting point was constant, and as thus obtained was a white crystalline substance, very soluble in ether and water, which, dried at 100°, melted with effervescence and decomposition at 191·5° corr. Aconitic acid melts with effervescence at 191°, undergoing decomposition into carbonic anhydride and itaconic acid.

The aqueous solution was very acid to test paper, and on the addition of silver nitrate in aqueous solution no precipitate was obtained, but after neu-

tralisation with ammonia, the addition of aqueous silver nitrate caused a white flocculent precipitate.

The silver salt was prepared for analysis as follows :—the acid was neutralised with aqueous sodium hydroxide, and excess of silvernitrate added, the precipitate collected, well washed with water, dried, and the amount of contained silver determined by ignition.

0·0382 gram acid required for neutralisation 12·5 cc. $\frac{N}{20}$ soda.

0·0758 gram silver salt gave 0·0494 gram silver.

Percentage of silver found 65·17.

Calculated for aconitic acid, 13·1 cc. $\frac{N}{20}$ soda and 65·45 per cent. silver.

The acid is, therefore, aconitic acid.

Atisine.

The base itself has only been obtained as a colourless varnish, which could not be obtained in the crystalline condition. It is prepared as follows :—the aqueous solution of a salt (preferably the hydrochloride) is rendered alkaline by the addition of aqueous sodium hydroxide, and the alkaloid, which is precipitated in white flocks, is extracted by shaking with ether. The ethereal solution is shaken with water till free from alkali, and then dried by agitation with calcium chloride, and distilled.

The base is left as an amorphous, colourless varnish, which is slightly soluble in water, freely soluble in alcohol, ether, or chloroform, and insoluble in petroleum ether. It readily undergoes decomposition by heat, becoming brown in colour, and forming a resinous substance. Attempts were made to crystallise it by the spontaneous evaporation of ethereal and alcoholic solutions, and by the addition of petroleum ether to ethereal, alcoholic, or chloroformic solutions, but all attempts failed to obtain it in the crystalline condition.

It was of interest to observe the action of atisine in solution on a ray of plane polarised light, since all the salts examined were found to be dextrorotatory, and in the case of the other aconite alkaloids it has been observed that the base has an opposite sign of rotation to that of its salts.

This was found to be the case with atisine, since a 6 per cent. alcoholic solution of the base was distinctly laevorotatory Owing to the fact that the determination had to be made with an amorphous base, not much reliance can be placed on the result obtained, which was as follows :—

Observed angle = a [19°] = — 2·64° (mean of 20 readings).

Length of tube = l = 2 decimetres.

Concentration = c = 6·728 grams per 100 cc.

$$\text{Whence } [a]_D (19^\circ) = -\frac{2{\cdot}64 \times 100}{2 \times 6{\cdot}728} = -19{\cdot}6^\circ$$

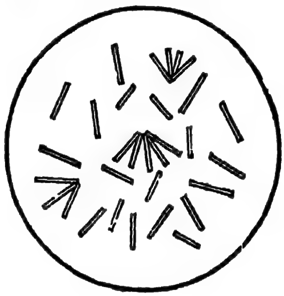
It is thus laevorotatory to about the same extent as the salts are dextrorotatory.

ATISINE HYDROCHLORIDE.

This salt is prepared by dissolving the base in aqueous hydrochloric acid, a faint excess of the acid being used; the solution is then concentrated by standing in a vacuous desiccator or by evaporation on the water bath, when a mass of white needle-shaped crystals are deposited. These may be purified by further crystallisation from water or from alcoholic solution, by the addition of ether, and allowing to stand in a stoppered bottle.

The salt may also be obtained by passing hydrogen chloride through an ethereal solution of the base, when it is precipitated as a white amorphous mass, which is then crystallised from alcohol and ether.

As thus obtained, the pure hydrochloride occurs as transparent crystals, in the shape of long prisms, occurring singly or in rosettes.



ATISINE HYDROCHLORIDE.

The crystals are anhydrous, when heated at 100°—130° for five hours suffering no loss of weight, are very soluble in water and alcohol, less so in benzene and acetone, sparingly soluble in dry chloroform and insoluble in ether and petroleum ether.

When dried at 100° they melt with decomposition and effervescence about 296° corr.

An aqueous solution of the salt is dextrorotatory, two determinations of the specific rotatory power giving the following results:—

(i) $\alpha[19°] = +0{\cdot}61°$ (mean of 20 readings). $l = 2$ decimetres. $c = 1{\cdot}691$ grams per 100 cc.

$$\text{Whence } [\alpha]_D = + \frac{{\cdot}61 \times 100}{2 \times 1{\cdot}691} = +18{\cdot}03°$$

(ii) $\alpha[24°] = +0{\cdot}38°$. $l = 2$ decimetres. $c = 1{\cdot}002$ grams per 100 cc.

$$\text{Whence } [\alpha]_D = + \frac{0{\cdot}38 \times 100}{2 \times 1{\cdot}002} = +18{\cdot}9°$$

Or the mean of the two determinations gives for atisine hydrochloride, $[\alpha]_D = +18{\cdot}46°$.

The chlorine, estimated in the usual manner by precipitation as silver chloride, gave :—

0·1776 gram salt gave 0·0684 gram silver chloride.
Chlorine = 9·53 per cent.

The molecular weight of the salt was determined by solution in glacial acetic acid and noting the depression of the freezing point. The results obtained were :—

Weight of salt taken . = 0·1676 gram.
Weight of solvent . . = 5·327 grams.
Depression of freezing point = 0·34°

$$\text{Whence M} = c \times \frac{p}{t}$$

$$= 39 \times \frac{3·146}{0·34} = 360·8.$$

The molecular weight of atisine hydrochloride is, therefore, 360·8.

Atisine hydrobromide.

This salt is prepared by dissolving the amorphous base in exactly the requisite quantity of aqueous hydrobromic acid, so that the resulting solution is neutral; the aqueous solution is then concentrated by slow evaporation on the water bath, with frequent stirring, when crystals of the hydrobromide separate. These may be purified by recrystallisation from water or from alcohol and ether. As thus obtained, the pure hydrobromide occurs as transparent crystals, in the shape of long needles occurring singly or in rosettes. The crystals are anhydrous, when heated at 100°—120° for three hours suffering no loss of weight, are freely soluble in water and alcohol, less so in chloroform, but insoluble in ether. When dried at 100° they melt with effervescence and decomposition at 273° corr.

An aqueous solution of the salt is dextrorotatory, a determination yielding the following results :—

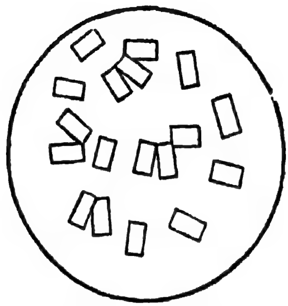
$\alpha\,[15°] = +\ 0·386°.$ $l = 2$ decimetres. $c = 0·7915$ gram per 100 cc.

$$\text{Whence } (\alpha)\,\text{D} = +\ \frac{0·386 \times 10}{2 \times 0·7915} = +\ 24·3°$$

Atisine hydriodide.

This salt could not be obtained by the action of aqueous hydriodic acid on the base, since iodine was liberated and a coloured substance —probably an iodo-derivative—formed. It is, however, very easily prepared by adding Mayer's re-agent to a solution of a salt of the alkaloid, and treating the precipitate as before described. Atisine hydriodide is also precipitated by the addition of aqueous potassium iodide to a strong aqueous solution of an atisine salt. The hydriodide is best purified by dissolving in boiling water, when, on cooling, a plentiful supply of crystals is obtained. It may also be crystallised by the spontaneous evaporation

of an alcoholic solution, or by the addition of ether to a solution in alcohol.



The crystals are transparent plates or tables, occuring singly or in rosettes; they are anhydrous, suffering no loss of weight when heated at 100°—130° for four hours. The salt is very sparingly soluble in cold, more so in hot water, sparingly soluble in alcohol or acetone, and almost insoluble in chloroform, ether, petroleum ether, or benzene.

A determination of the solubility of this salt in water gave the following results:—

(i) 6·9924 grams of solution at 90° yielded ·0926 gram salt.

Hence 1·3 grams of salt dissolves in 100 grams of water at 90°.

(ii) 8·7992 grams of solution at 15° yielded ·0182 gram salt.

Hence 0·2 gram of salt dissolves in 100 grams of water at 15o.

The salt is thus much more soluble in hot than in cold water; this affords a ready means of obtaining the salt in a pure condition.

The pure salt dried at 100° melts with decomposition and effervescence at 279°—280° corr. ‡

An aqueous solution of the salt is dextrorotatory, but accurate determinations of this constant were difficult, owing to the sparing solubility of the salt in water at the ordinary temperature:—

(i) a (mean of 10 readings) $= + 0·19°$ at 19°. $l = 4$ decimetres $c = 0·1808$ gram per 100 cc.

$$\text{whence } [a]_D\ 19° = + \frac{100 \times 0·19}{4 \times 0·1808} = + 26·2°.$$

(ii) $a = + 0·1°$ at 19°. $l = 2$ decimetres. $c = 0·174$ gram. per 100 cc.

$$\text{Whence } [a]_D\ 19° = + \frac{100 \times 0·1}{2 \times 0·174} = + 28·7.°$$

‡ Since all the salts of atisine melt with decomposition at rather high temperatures, very slight variation in the method of taking the melting point causes an alteration in the melting point recorded; all recorded in this paper are for the dried salt placed in a capillary tube, heated up slowly in a paraffin bath, with the thermometer immersed in the liquid to within about 10 millimetres of the actual melting point. As thus obtained the results are comparable with one another, which is all that is required for the purpose of purification.

These results are as near as can be expected when the small observed reading is considered, and their mean gives for

atisine hydriodide at 19°, $[\alpha]_D = + 27{\cdot}4°$.

The iodine was estimated in the usual manner by precipitation as silver iodide:—

(i) 0·1926 gram salt gave 0·097 gram silver iodide.
Iodine=27·21 per cent.

(ii) 0·0926 gram salt gave 0·0462 gram silver iodide.
Iodine=27·02 per cent.

(iii) 0·8272 gram salt gave 0·4114 gram silver iodide.
Iodine=26·87 per cent.

(iv) 0·2636 gram salt gave 0·1312 gram silver iodide.
Iodine=26·89 per cent.

Mean of four determinations: iodine=26·90 per cent.

The salt was also burnt in a current of oxygen over lead chromate with the following results:—

(i) 0·1652 gram salt gave 0·1086 gram H_2O and 0·3468 gram CO_2.
Carbon=57·02 per cent. Hydrogen=7·30 per cent.

(ii) 0·0914 gram salt gave 0·0598 gram H_2O and 0·1904 gram CO_2.
Carbon=56·77 per cent. Hydrogen=7·28 per cent.

Mean of two determinations: $\begin{cases} \text{Carbon} = 56{\cdot}89 \text{ per cent.} \\ \text{Hydrogen} = 7{\cdot}29 \text{ per cent.} \end{cases}$

The nitrogen was estimated both by the soda lime and by the absolute methods, and yielded the following results:—

0·2771 gram of salt yielded ammonia which required for neutralisation 5·51 cc. $\frac{N}{10}$ acid. N=0·007714 gram.

Percentage of nitrogen=2·78.

Burnt in a Sprengel vacuum with powdered copper oxide, and, in one case, with a mixture of powdered lead chromate and copper oxide:—

0·3753 gram salt gave 11 cc. moist nitrogen at 13° and 755·4 mm.
Percentage of nitrogen=3·44.

0·2756 gram salt gave 7·7 cc. moist nitrogen at 14° and 766·4 mm.
Percentage of nitrogen=3·31.

0·3026 gram salt gave 8·5 cc. moist nitrogen at 18° and 764 mm.
Percentage of nitrogen=3·26.

Mean of above four determinations: nitrogen=3·19 per cent.

Burnt in an open tube in a current of CO_2, and the gas collected over aqueous potassium hydroxide:—

0·1128 gram salt gave 6·4 cc. moist nitrogen at 17° and 772·2 mm.
Percentage of nitrogen=6·55.

0·23 gram salt gave 13 cc. moist nitrogen at 18° and 752 mm.
Percentage of nitrogen=6·45.

0·2343 gram salt gave 13 cc. moist nitrogen at 15° and 760 mm.

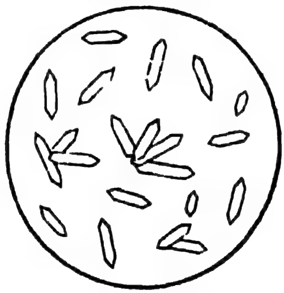
Percentage of nitrogen=6·50.

Mean of above three determinations: nitrogen=6·50 per cent.

The gas obtained in one of the last experiments was analysed, and found to contain no carbonic oxide or oxygen, and when exploded with oxygen and electrolytic gas (H and O) gave no contraction. These results are discussed in the consideration of the formula of the alkaloid.

Atisine nitrate.

This salt is best obtained by adding slight excess of aqueous silver nitrate to a hot aqueous solution of the pure hydriodide, filtering off the precipitated silver iodide, removing the excess of silver nitrate, by adding a few drops of dilute aqueous hydrochloric acid, filtering off the precipitated silver chloride, neutralising the filtrate with dilute ammonia, and concentrating the aqueous solution on the water bath. On cooling, the salt crystallises out in very well-defined plates of hexagonal shape. They are best purified by re-crystallising first from water, and then from alcohol and ether, by adding ether to an alcoholic solution of the salt till there is a permanent turbidity, and allowing it to stand in a stoppered bottle.



Atisine nitrate.

The crystals, which may occur singly or in rosettes, are anhydrous like the other salts of atisine, since they suffer no loss of weight when heated at 100°—110° for four hours. They are soluble in water, particularly in hot water, fairly soluble in benzene and acetone, more so in alcohol, sparingly soluble in chloroform, and insoluble in ether and petroleum ether. Dried at 100°, the salt melts sharply to a clear liquid without decomposition at 252° corr., effervescence with decomposition taking place immediately afterwards.

The salt in aqueous solution is dextrorotatory, a determination giving the following results :—

a (mean of 10 readings) = +0·58° at 18°. l = 2 decimetres. c = 1·0255 grams per 100 cc.

$$\text{Whence } [a]_D \ (18°) = + \frac{0·58 \times 100}{1·0255 \times 2} = + 28·3°$$

Burnt in a stream of oxygen over copper oxide the following results were obtained:—

(i) 0·1440 gram salt gave 0·1032 gram H_2O and 0·3458 gram CO_2.
Carbon = 65·48 per cent. Hydrogen = 7·96 per cent.

(ii) 0·1820 gram salt gave 0·1302 gram H_2O and 0·4368 gram CO_2.
Carbon = 65·43 per cent. Hydrogen = 7·94 per cent.

(iii) 0·138 gram salt gave 0·1032 gram H_2O and 0·3294 gram CO_2.
Carbon = 65·14 per cent. Hydrogen = 8·26 per cent.

(iv) 0·1322 gram salt gave 0·097 gram H_2O and 0·3184 gram CO_2.
Carbon = 65·68 per cent. Hydrogen = 8·15 per cent.

Mean of four determinations : $\begin{cases}\text{Carbon} = 65{\cdot}43 \text{ per cent.}\\ \text{Hydrogen} = 8{\cdot}08 \text{ per cent.}\end{cases}$

The nitrogen was estimated both by the soda lime and by the absolute methods, and yielded the following results :—

0·1619 gram salt yielded ammonia which required for neutralisation 5·5 cc. $\frac{N}{10}$ acid. N = ·0077 gram.

Percentage of nitrogen = 4·8.

Burnt in a Sprengel vacuum with powdered copper oxide and lead chromate :—

0·1588 gram salt gave 9·5 cc. moist nitrogen at 13° and 761·5 mm.
Percentage of nitrogen = 7·08.

Burnt in an open tube in a current of CO_2, and the gas collected over aqueous potassium hydroxide :—

0·1586 gram salt gave 12·8 cc. moist nitrogen at 18° and 760 mm.
Percentage of nitrogen = 9·53.

0·2058 gram salt gave 17·4 cc. moist nitrogen at 18° and 768·3 mm.
Percentage of nitrogen = 10·00.

0·125 gram salt gave 11·5 cc. moist nitrogen at 16° and 757 mm.
Percentage of nitrogen = 10·6.

The gas obtained by the latter method was analysed, and found to contain no carbonic oxide or oxygen and, when mixed with oxygen and an electric spark passed, there was no contraction of volume. These results are discussed under the formula of atisine.

Atisine auricloride.

This salt was prepared by adding an aqueous solution of auric chloride to an aqueous solution of atisine hydrochloride acidified with hydrochloric acid, when a yellow precipitate is formed, which, however, at once aggregates to form an oily clot. This, when washed with water and dried *in vacuo*, can be powdered, and is then a yellow amorphous powder which has, hitherto, resisted all attempts to obtain it in a crystalline condition. It is soluble in alcohol, sparingly soluble in chloroform, and insoluble in ether and petroleum ether.

A specimen of the salt prepared as above, powdered, and dried in a vacuous desiccator over calcium chloride till of constant weight, gave the following figures on analysis:—

0·0682 gram gold salt gave on ignition 0·0202 gram of gold.

Gold=29·61 per cent.

Atisine platinichloride.

This salt was used by Broughton for the purpose of analysis, but Wasowicz was unable to obtain it. It is, however, easily prepared by adding an aqueous solution of platinic chloride to a strong aqueous solution of atisine hydrochloride acidified with hydrochloric acid. An almost white precipitate forms, which, on stirring vigorously, becomes crystalline and sinks to the bottom of the liquid. These crystals are washed with hot water and then dried.

As thus obtained, atisine platinichloride is a crystalline powder of a yellow-brown colour, sparingly soluble in cold, more so in hot water, which, when dried at 100°, melts sharply with effervescence at 229° corr.

The estimation of the platinum contained in the salt was carried out in the following manner, so as to recover the alkaloid. A weighed quantity of the salt is dissolved in hot water, and hydrogen sulphide passed through the solution to saturation: the precipitate and liquid is then boiled for some time, when the platinum sulphide separates as a dark brown precipitate, which is filtered off, dried, ignited, and the resulting platinum weighed. The filtrate on evaporation yields atisine hydrochloride.

0·0609 gram platinum salt, dried at 100° till of constant weight, yielded 0·011 gram platinum. Platinum=18·06 per cent.

The Formula of Atisine and its Salts.

The physical characters of the alkaloid and its salts, above described, show clearly that it is identical with the atisine examined by Broughton and Wasowicz; it is, therefore, proposed to retain the name atisine for the base. Three formulæ for atisine must then be considered:—(i.) that proposed by Broughton and modified by Wasowicz—$C_{46}H_{74}N_2O_4$; (ii.) the formula corresponding to this, but of half the molecular weight—$C_{23}H_{37}NO_2$—for the analytical data would agree equally well for either formula, if the base be considered di-acid as asserted by Broughton; (iii.) that proposed by Wright, based on a single analysis of the amorphous gold salt—$C_{22}H_{31}NO_2$. The first of these formulæ cannot be adopted, for the determination of the molecular weight of the hydrochloride, by Raoult's method of the depression of the freezing point of the solvent, gave a result closely approximating to half the calculated value.

Calculated for $C_{46}H_{74}N_2O_4$—718.—Found 324·3.

Aconitum heterophyllum. (*H. A. D. Jowett.*)

There remain then for consideration the formulæ—

$C_{23}H_{37}NO_2$ and $C_{22}H_{31}NO_2$.

The results of a large number of analyses of different salts of atisine show that the latter formula is the correct one, and was, in fact, deduced from the figures of analysis before the formula proposed by Wright was known to the author.

The following table shows the calculated value for the two formulæ and those found by experiment:—

ANALYSES OF ATISINE AND ITS SALTS.

	Calc. for $C_{23}H_{37}NO_2$ (base).	Found.	Calc. for $C_{22}H_{31}NO_2$ (base).	Salt analysed.	Analyst.
	Per cent	Per cent.	Per cent.		
Carbon . .	76·68	76·75	77·41	Base (amorphous)	Wasowicz.
Hydrogen .	10·30	10·66	9·09		
Carbon . .	65·40	65·43	65·34	Nitrate	Jowett.
Hydrogen .	9·00	8·08	7·92		
Nitrogen .	6·63	7·08	6·93		
Carbon . .	56·67	56·89	56·29	Hydriodide	Jowett.
Hydrogen .	7·80	7·29	6·82		
Nitrogen .	2·8	3·19	2·99		
Iodine . .	26·07	26·99	27·07		
Chlorine . .	8·95	9·53	9·38	Hydrochloride	Jowett.
Molecular wt.	395·4	360·8	777·4		
Carbon . .	39·54	38·04	38·82	Aurichloride (amorphous)	Wright. ‡Jowett.
Hydrogen .	5·44	5·09	4·70		
Nitrogen . .	2·00	2·05	2·05		
Gold . .		28·72 ‡ / 29·61 ‡	28·82		
Platinum .	17·22	18·06	17·78	Platinichloride	Jowett.

The formula $C_{22}H_{31}NO_2$ is, therefore, adopted for atisine.

A difficulty was encountered in the estimation of the nitrogen contained in the hydriodide and nitrate, similar to that met with in the case of aconitine.[19]

Burnt with copper oxide and lead chromate in a closed tube, which had been rendered vacuous by a Sprengel pump, and collecting the gas through the limb of the pump, results were obtained which agreed very closely with those calculated for a molecule containing one atom of nitrogen. The nitrogen contained in the hydriodide, estimated by the soda-lime method, was also found to agree for this formula.

When, however, the salts were mixed with copper oxide and burnt in a current of carbonic anhydride (by Dumas' method), results were obtained which agreed better for a formula containing two atoms rather than one nitrogen atom.

The gas did not explode when mixed with oxygen and sparked in the usual manner, and it was not possible, owing to the small quantity of gas

obtained, to analyse it by passing it over heated copper oxide, and noticing if there was any change of volume. These high results obtained must be due then to the presence of a gas other than nitrogen, and it is probable that this gas is methane, as in the case of aconitine, but this point was not further investigated. It is a curious coincidence that this same difficulty should be encountered in the case of atisine and aconitine, since in all other respects there seems to be no point of resemblance between the two alkaloids.

The Action of Alkalies on Atisine.

Most alkaloids, particularly the aconite alkaloids, undergo hydrolysis on treatment with alkali, yielding an acid or acids, occasionally an alcohol and a new base. The action of alkali on atisine was therefore investigated and, though a base having properties distinct from atisine was formed, yet no acid, or any other product of the reaction could be detected.

Several experiments were made, both in aqueous and alcoholic solution with negative results, and of these the following is a typical example. About 1·5 grams of pure atisine were dissolved in dilute sulphuric acid and pure aqueous sodium hydroxide added in excess. The mixture of the liquid and the dense white precipitate of atisine was then heated in a sealed tube at 120°-130° for three hours. The liquid was then rendered neutral with aqueous sulphuric acid and distilled, when no distillate but water was obtained.

The liquid was then rendered acid, and distilled into a known quantity of $\frac{N}{20}$ aqueous sodium hydroxide. No acid distilled, as was proved by titration of the alkali in the distillate after the experiment. The acid liquid was then extracted by shaking with ether, but after removal of the ether by distillation no residue was obtained. The acid liquid was then rendered alkaline with pure sodium hydroxide, and a white precipitate was obtained, which, unlike atisine, was not at all bulky or flocculent. This was extracted by shaking with ether four or five times. The alkaline liquid, after neutralisation, was evaporated to dryness; and the residue, on analysis, was found to consist of sodium sulphate.

The base obtained, after removal of the ether by distillation, could not be obtained crystalline, and all efforts to crystallise the salts—hydrochloride, hydrobromide, hydriodide and nitrate—failed.

The aurichloride was prepared by adding excess of aqueous aurichloride to an acid solution of the hydrochloride of the base, when a pale yellow precipitate was obtained. This, when filtered off, yielded a yellow amorphous powder, which could not be crystallised.

On analysis it yielded the following results:—

0·1026 gram gold salt, dried on a porous tile, gave, on ignition, 0·0292 gram gold. Gold = 28·4 per cent.

0·0904 gram gold salt dried in a vacuous desiccator over P_2O_5, till of constant weight, gave, on ignition, 0·0252 gram gold.

Gold = 27·8 per cent.

0·0549 gram gold salt, dried in a desiccator for three months, gave, on ignition, 0·0151 gram gold.

Gold = 27·55 per cent.

0·171 gram salt, dried in a desiccator till of constant weight, gave 0·0784 gram H_2O and 0·239 gram CO_2.

Carbon = 38·01 per cent. Hydrogen=5·08 per cent.

In order to be certain that the salt was homogeneous, it was precipitated in two fractions, and each fraction analysed.

First fraction:—

0·0588 gram salt gave on ignition 0·0165 gram of gold.

Gold =28·06 per cent.

Second fraction:—

0·037 gram salt gave on ignition, 0·0104 gram of gold.

Gold=28·1 per cent.

The fractions were therefore identical, and the aurichloride, though amorphous, was homogeneous.

These figures agree best for a base, whose formula is represented by the addition of the elements of water to atisine.

	Found.	Calc. for $C_{22}H_{31}NO_2 \cdot H_2O \cdot HAuCl_4$.
Gold . .	27·9 per cent. . . .	28·08 per cent.
Carbon . .	38·01 „ . . .	37·82 „
Hydrogen .	5·08 „	4·87 „

Since no product of this reaction other than the new base could be detected, the action of alkali on atisine consists in the addition of the elements of water, a hydrate being formed, as in the case of strychnine.

The platinum salt was also prepared in the usual manner, and is a pale yellow amorphous powder, insoluble in cold, sparingly soluble in hot water. It melts indefinitely about 236° corr. with effervescence and decomposition. When heated at 100° it undergoes no loss of weight, the re-action with alkali is, therefore, not one of simple hydration, but the change is one which occurs in the molecule itself.

The platinum salt, on analysis, yielded the following results:—

0·0536 gram platinum salt gave 0·0094 gram platinum.

Platinum = 17·53 per cent.

0·0928 gram platinum salt gave 0·0156 gram Pt. and 0·0672 AgCl.

Platinum = 16·81 per cent. Chlorine = 17·88 per cent.

	Found.	Calc. for $(C_{22}H_{31}NO_2H_2O)HCl_2 \cdot PtCl_4$.
Platinum . .	17·17 per cent.	17·21 per cent.
Chlorine . .	17·91 „	18 „

Owing to the failure to obtain crystalline salts of this base, the properties of the base and its salts could not be studied.

Action of Acids on Atisine.

Dilute mineral acids were found to react with atisine in precisely the

same manner as alkali, causing the addition of the elements of water, and resulting in the formation of a new base—atisine monohydrate.

The pure base was dissolved in dilute sulphuric acid (10 per cent.) and heated in a sealed tube at 130 for five hours, and the base isolated in the same manner as described in the previous section. The platinichloride agreed in all respects with that obtained by the action of alkali on the base, it melted at 234 corr., and gave, on analysis :—

0·0298 gram salt gave ·0051 gram Pt. Platinum = 17·11 per cent. Calculated for $(C_{22}H_{31}NO_2H_2O{\cdot}HCl)_2$, wt. Cl_4 Platinum = 17·21 per cent.

Action of Hydrogen Iodide on Atisine.

In order to determine if any methoxyl groups were present in atisine about ·5 gram of the pure hydriodide was heated with fuming hydriodic acid (s. g. 1·7) for two hours, and the resulting vapours passed first over amorphous phosphorus and then through a solution of silver nitrate in aqueous alcohol. No precipitate was formed, and on further heating no precipitate was noticed. The base thus contains no methoxyl groups.

Distillation of Atisine with Soda Lime.

A quantity of pure atisine hydriodide was intimately mixed with powdered soda lime and then heated in a distilling flask. White fumes were given off, which condensed to a white substance, having the odour of a cresol. It was insoluble in cold water, slightly soluble in hot water, and easily soluble in alcohol and ether. Its aqueous solution yielded a white precipitate with bromine water. Lack of material prevented further investigation of this substance.

The result of this investigation shows that atisine does not present any analogies to the alkaloids of the other species of the aconites. The molecule is less complex and much more stable, not undergoing change by alkalies or acids, except the addition of the elements of water, from which it might be inferred that atisine is the anhydride of an alkaloid of the formula $C_{22}H_{33}NO_3$, but further experiments on this point are required.

Dr. Cash, F.R.S., who kindly examined the physiological action of atisine nitrate, reports that in its action it somewhat resembles aconitine. Judging from the formulæ of aconine and atisine, however, there would seem to be no analogy between these two bases, for aconine is $C_{20}H_{27}(OCH_3)_4{\cdot}NO_6$, whilst atisine monohydrate is $C_{22}H_{33}NO_3$.

Atisine thus seems to have no connection with the other aconite alkaloids, a fact which is rather unexpected, considering the connection which exists between the alkaloids of the other species of aconite.

The material used in this investigation was furnished by the Imperial Institute, and the enquiry has been conducted in the Research Laboratory of the Pharmaceutical Society. In conclusion I desire to express my warmest thanks to Professor Dunstan both for the suggestion which led to this research and for the kindly interest he has taken in the progress of the work.

A. 401.

of Aconitum heterophyllum. (*H. A. D. Jowitt.*)

ACONITUM heterophyllum.

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(Mineral and Metallic Series, No. 8.)

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REH.

[*Dictionary of Economic Products, Vol. VI., Pt. I.,* R. 67-70.]

RECLAMATION OF REH OR USAR LAND.

Report on Usar Reserves in the North-West Provinces, for the year 1893-94 by* MR. J. F. DUTHIE, *Director, Botanical Department, Northern India.*

REPORT ON THE USAR RESERVES IN THE ALIGARH DISTRICT FOR THE YEAR 1893-94.

I visited Aligarh in February last and made a careful examination of the plots which have been under observation at the Chherat and Gursikran reserves since February 1888.

CHHERAT RESERVE.

Plot 3.—This plot which used to be almost bare is now nearly all covered with grass; the growth of *dub* grass and *janewar* (Andropogon annulatus) has increased.

Plot 4.—This was also a very bare plot in 1888. The *usar* grass (Sporobolus pallidus) has now extended over the eastern side. The patches of *dub* and *dáb* (Eragrostis cynosuroides) have increased in size, and *janewar* is plentiful on the raised portions.

Plot 5.—Still rather bare, and the grass which does exist is thin.

Plot 6.—Nearly all covered with grass.

Plot 7.—Completely covered with the exception of two small patches.

Plot 8.—The whole of this, excepting a few small spots, is covered with healthy *usar* grass. A good deal of this grass was in a sickly condition in 1888. One patch surrounding a strip of *dub* grass was evidently injured by excessive moisture, the *dub* benefiting thereby.

Plot 9.— This plot is now completely clothed with grass which, however, is rather thin in a few places.

* Delayed in publication.—ED.

REH.	Reclamation of Reh
ALIGARH DISTRICT. Chherat reserve.	

Plot 10.—The grass covering is rather thin in this plot, due probably to over-grazing. The dead patches of *usar* grass have been replaced.

Plot 11.—The patch of *dub* on the south boundary line has disappeared, but at the north end of the plot *dub* grass has appeared in considerable quantity, also *dáb*.

Plot 12.—The grass growth in this plot has much extended.

Plot 14.—Grass very thin; the growth of *dub* and *dáb* has, however, extended.

Plot 15.—Grass growth has slightly increased, but the plot is still nearly bare.

Plot 21.—There is now very little *usar* grass in this plot. There are some good patches of *dub*, and some of *dáb*, the remainder of the plot is occupied by *bat* (**Diplachne fusca**) artificially sown.

Plot 22.—The growth of *dub* has much extended. The *usar* grass has mostly disappeared, owing to excess of water at the roots, and has been replaced by *bat* grass sown artificially.

Plot 23.—The greater portion of this plot is now occupied by *bat*. A few good patches of *dub* also occur.

Plot 24.—This plot, which used to be almost bare, is about half covered now with *bat*, thin *usar* grass and *dub*.

Plot 25.—Thinly covered with *usar* grass, which has extended over what used to be bare ground. There are some good patches of *dub* and *dáb* in the south-west corner.

Plot 26.—This plot is fairly well clothed now with healthy *usar* grass, with the exception of a few bare places near the footpath. The large patch of dead *usar* grass has been replaced.

Plot 27.—Covered with healthy *usar* grass.

Plot 28.—The patches of *dub* have spread, and the *usar* grass is healthy.

Plot 29.—The bare patch recorded in 1888 is thinly covered over, but other bare patches have made their appearance in the north-west corner. The grass is still rather thin in the north-west corner near the footpath. There is a fine patch of *janewar* on the south boundary line.

Plot 30.—This plot is very bare along the centre, a good deal of the *usar* grass having died from excessive moisture.

Plot 31.—Very bare, the *usar* grass having been killed by too much water.

Plot 45.—The bare patch recorded in 1888 is now covered with grass and the patches of dead *usar* grass have been replaced.

Plot 46.—The patches of dead *usar* grass have been replaced, and the growth of *dub* has spread.

Plot 47.—The dead patches of *usar* grass in the south-west corner have been replaced, and the *dub* growth has extended.

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Plot 48.—The patch of dead *usar* grass in the north-east corner has been replaced. The grass covering is rather thin in the neighbourhood of the water-hole. A clump of *dáb* has appeared on one side of this hole.

Plot 49.—The patch of dead *usar* grass in the south-east corner has been replaced. The upper portion of this plot is still rather thin and bare in places.

Plot 50.—There are many bare places in this plot owing to the destruction of *usar* grass by water. Patches of *dub* and *dáb* have, however, appeared.

GURSIKRAN RESERVE.

Plot 1.—The bare portion along the upper boundary line was caused by a deposit of reh salts washed down from the canal Rájbahár, which forms the northern boundary of plots 1, 14, 15, 28 and 29. The other bare patches in this plot have been under observation since 1888, and the measurements made from time to time show that the *usar* grass has been gradually encroaching over them. They are now completely covered with a thin coating of this grass. The water-hole is very much as it was in 1888 with a fringe of Cyperus (sedge) and *dub* grass round the edge. The large patch of dead *usar* grass has since been replaced by healthy growth.

Plot 2.—The bare places are now all completely covered with a thin coating of grass.

Plot 3.—The bare patch at the upper right-hand corner, which in 1888 was covered with a thick deposit of reh salts, is now completely clothed with a thin coating of grass. The other bare places have disappeared. A small spot with a rather thin coating of grass indicates the position of a large bare patch which formerly existed on the lower boundary line. The drainage depression is filled with Cyperus and *dub* and with scattered tufts of *gándár* grass (Anthistiria prostata).

Plot 4.—A thinly covered spot on the upper boundary line is the only evidence of the large bare patch which existed here in 1888. The patch of dead *usar* grass has been replaced. The right-hand lower corner, formerly bare, is now entirely covered.

Plot 5.—The bare patch in the right-hand upper corner is now all thinly covered with grass; also the one on the left-hand boundary line. The grass in the left-hand lower corner is rather thin.

Plot 6.—The grass is rather thin in the left-hand upper corner, also in the right-hand lower corner. The large patches of dead *usar* grass have been replaced. The water-hole on the right-hand boundary line is edged with *dub* and *gándár* grass.

Plot 7.—The bare patches are all covered, but the grass is still rather thin. The patches of *dáb* have extended. The piece of raised ground on the upper boundary line is covered with *ber* bushes surrounded by *dub* and *dáb.*

Plot 8.—The bare places are all covered. The grass is thin in the left-hand lower corner and along the lower boundary line. A large and luxu-

REH.	Reclamation of Reh

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riant patch of *dub* grass extends from the left-hand upper corner towards the centre of the lower boundary line, as in 1888. The growth of *dáb* grass has spread very much in this plot.

Plot 9.—The white patch in centre of the plot which existed in 1888 is now thinly covered with grass.

Plot 10.—The greater portion of this plot was absolutely bare in 1888. A few bare places still exist, and the grass is rather thin here and there.

Plot 11.—The bare portion of this plot has been much reduced. The two bare places close to the road are now covered.

Plot 12.—All the bare patches have disappeared. The grass is rather thin on the upper boundary line. The *dub* grass fringing the water-hole has spread considerably. Mixed with the *dub* are some clumps of *gándár* and *janewar* grasses.

Plot 13.—The bare places are all covered with a thin coating of grass.

Plot 15.—The two bare patches noticed in 1888 are now completely covered.

Plot 16.—A small patch on the left boundary line, rather thinly covered with grass, is the only evidence of the bare places existing in 1888. The patches of dead *usar* grass have been replaced.

Plot 17.—More than half of this plot was absolutely bare and efflorescent in 1888. It is now almost entirely covered with healthy *usar* grass.

Plot 18.—This plot was also very bare except the central portion. Only two small bare patches near the right-hand upper corner remain. The water-hole near the centre of the plot is filled with *dub* and *gándár*.

Plot 19.—In 1888 this was the barest of all the plots. Its condition is now almost exactly the reverse, as the bare portion which remains is about equal in area to the grass-covered surface in 1888. The rectangular figure which occupies a portion of this plot and of Nos. 20, 23 and 24 represents four plots enclosed within shallow *bands*, and refers to some experiments carried out here previous to 1888. The raised banks forming the *bands* are now more or less clothed with *dub* grass.

Plot 20.—The *usar* grass has spread over the left-hand upper corner. There is still a certain amount of bare surface in this plot and the grass is rather thin towards the centre.

Plot 21.—A bare white patch, noticed in 1888 at the right-hand lower corner, is now covered with a thin coating of grass. Along the upper boundary is a large strip of luxuriant *dub* grass, and there are several large patches of *dáb* grass which were not noticed in 1888.

Plot 22.—No trace can now be seen of a large bare patch which was formerly noticed in the centre of this plot. Another bare place in the left-hand upper corner is now covered with a thin coating of grass. *Dáb* grass has much extended over this plot.

Plot 23.—The left-hand lower corner, which used to be quite bare, is now covered with grass, and only a small bare patch remains in the right-hand upper corner. There are some clumps of *bat* grass (Diplachne fusca) at the upper portion of this plot, and within the *band*.

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Plot 24.—Contains at present a larger amount of bare efflorescent surface than any of the other plots, but less, however, than it did in 1888.

Plot 25.—All the bare patches are covered. There is an abundant growth of *dub* grass in the left-hand upper corner. The *usar* grass is rather thin near the centre of the plot.

Plot 26.—The growth of *dub* grass, shown in plot 25, has extended also into the lower portion of this plot. The bare place noticed in 1888 at the right-hand lower corner is now entirely covered with healthy *usar* grass. Two bare patches on either side of the drain remain as they were. The ground below the *kikar* tree near the centre of the plot has become rather bare.

Plot 27.—The large bare patch noticed in 1888 near the road is now covered with a thin coating of *usar* grass. There are two small bare patches in the left-hand lower corner, the one on the left-hand boundary line being evidently connected with the extensive bare piece of ground which used to exist in portions of plots 30 and 31. There is also a thinly covered spot on the right-hand boundary line which is an extension of the bare patch in the adjacent plot 16.

Plot 28.—The bare strips extending along the upper and left-hand boundary lines were caused by the washing down of reh salts from the bank of the Rájbahár, which extends along the northern boundary of this plot. The grass has now grown all over these strips, and there are now no traces left of the two bare patches which existed in 1888. The strip of *dub* grass near the centre of the plot has increased in size.

Plot 29.—The growth of *dub* grass has extended considerably westwards.

Plot 30.—With the exception of a very small bare spot near the right-hand lower corner all the bare parts have been covered, and the patches of dead *usar* grass have been replaced by healthy growth. A large patch of *dáb* grass has made its appearance in the left-hand corner.

Plot 31.—All bare places have been covered. One of them on the left-hand side of the road was in 1888 coated with a thick layer of powdery reh salts. The grass is rather thin in one place. A luxuriant growth of *dub* grass in the right-hand lower corner is extending.

Plot 32.—All bare patches have disappeared, and the dead *usar* grass has been replaced. The water-hole near the lower boundary line is now edged with *gándár* grass.

Plot 33.—All bare places are now covered with grass.

Plot 34.—The bare patches noticed in 1888 are now all clothed with grass. The clumps of *dáb* grass are extending, owing to some new drainage channels made since 1888.

PROPOSALS REGARDING FURTHER OBSERVATIONS ON THE VEGETATION OF THE EXPERIMENTAL PLOTS.

In my last report I mentioned that a large portion of the JUHI RESERVE, near Cawnpore, might be considered as practically reclaimed. I think,

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therefore, that it will be unnecessary to continue the periodical observations regarding any further possible changes in the vegetation of the experimental plots of that reserve. The CHHERAT RESERVE I have always looked upon as being much less favourable for observing changes in the vegetation resulting from protection than that of GURSIKRAN. A large portion of the ground occupied by the experimental plots is under water during the rainy season, and the amount of water which accumulates and remains stagnant varies according to the rainfall of each year. This causes a series of corresponding changes in the vegetation, which, to a great extent, interfere with those resulting from mere protection. I have also been informed by the Director of Land Records and Agriculture that additional grazing ground is now required for the cattle attached to the Dairy Farm. I, therefore, propose that the periodical records of the condition of *usar* vegetation be confined to the experimental plots in the Gursikran reserve.

Periodical records may now be confined to Gursikran reserve.

The carrying out of this proposal need not interfere with any experiments which may be considered desirable in the way of tree-planting, and if it is decided to retain the Chherat reserve mainly for grazing purposes, a good deal could be done towards improving the herbage by periodical sowings of suitable grass seeds. In the case of one kind of grass called *bat* (Diplachne fusca), and alluded to in my notes on the experimental plots, considerable progress has already been made at Chherat towards extending its growth by means of artificial sowings. This is a very useful species for replacing the *usar* grass (Sporobolus pallidus) on the low-lying portions, where water is liable to accumulate for any length of time. It is also a very nutritious grass and much liked by buffaloes. Within this reserve are other good fodder grasses, such as *dub*, *jánewar* (Andropogon annulatus), *anjan* (Cenchrus pennisetiformis), *gándár* or *musel* (Anthistiria prostata), etc., the seed of which could be utilized for extending their area on suitable spots.

THE RESULTS OF RECENT EXPERIMENTS.

Conf. Agricultural Ledger, 1893, Nos. 12, 13, page 3.

1. *River-sand Experiment.*—In my report for 1892-93 I mentioned that, at the suggestion of Mr. C. E. Gladstone, Deputy Commissioner of Umballa, an experiment on a small scale was being tried at the Chherat reserve. A piece of typical *usar* ground, close to the Dairy Farm, and measuring 2,500 square yards, was selected. Over the surface of this plot a layer of pure river-sand, 3 inches in thickness, was spread and ploughed in. This took place at the beginning of last cold weather. Although this top-dressing of sand cannot be expected to have had its full effect on the vegetation until after the rainy season is over, an appreciable difference was nevertheless noticeable, even in February last, in the more vigorous growth of the grasses within the sand-covered plot compared with that of the surrounding ground. The Assistant Director of Agriculture, who has been good enough to superintend this experiment, calculates that the weight of sand required

to cover one acre, 3 inches thick, would equal 10,400 maunds, and that the cost of carrying that amount from the nearest spot where river-sand is procurable, *viz.*, 14 miles, would come to R780. Owing to the characteristic constitution of *usar* soil, in which clay, and not sand, forms the medium through which the reh salts reach the surface of the ground, I doubt if any large extent of *usar* land exists sufficiently near to places where river-sand is procurable.

ALIGARH DISTRICT.

Results of recent experiments.

Cultivation of *Dhak* recommended.

2. ***Sowings of Dhak*** **(Butea frondosa)**—The cultivation of this tree, which is known to thrive in reh-infected soil, has not yet been attempted at any of the *usar* reserves on a scale sufficient to ensure a reasonable amount of success. The planting out of single specimens in isolated positions on an open *usar* plain is, I think, a mistake, not only in the case of the *dhák*, but for any kind of tree or shrub which may be considered to have any chance of thriving on such land. The young plants require all the protection that can be given to them at the outset, and the most economical is that which they are able to give to each other. They should therefore be planted close together.

With this view I would recommend that half an acre of land be selected either at the Chherat or Gursikran reserve and pegged off. After one or two ploughings *dhák* seed should be sown broadcast, and, if possible, just before the regular rainy season commences. At the same time another batch of seed should be sown in a nursery, the soil of which has been previously prepared, for it is quite possible that the broadcast sowings may fail. Next year the seedlings resulting from either of these sowings should be transplanted close together into another prepared half acre, or into the same plot where the broadcast sowings were made, should the latter have failed. In any case the nurseries should be maintained, so that a certain number of one-year old seedlings may be available every year for the permanent plantation.

The following remarks by Dr. Voelcker in his "*Report on the Improvement of Indian Agriculture,*" *page 156*, seem to call for some such action being taken:—

Remarks by Dr. Voelcker.

"Of the success which may be achieved by growing trees on salty land the instance of the Phagwara tahsil, in the Kapurthala State, given in Chapter V., paragraph 75, affords proof. The 9,000 acres taken up included 7,660 acres that were not fit for cultivation owing to the soil being impregnated with soda salts (*kalar*), *usar* land in fact; yet the *dhák* tree (Butea frondosa) grows here capitally supplying 40,000 maunds of fuel annually. The sale-proceeds from this and from grazing fees amount to R9,000 per annum, with an expenditure of only R540. The growing of *dhák* has one great advantage, in that cattle, sheep, and goats will not touch the tree, and consequently grazing does not harm it. The growing of *dhák* ought certainly to be much more extensively tried on *usar* land, especially seeing what quantities of such land there is in the North-West Provinces alone. The experiments

REH.	Reclamation of Reh or Usar Land.

ALIGARH DISTRICT.

made up to now on *usar* land have been directed mainly to enclosing and growing grass on it. I should like to see the growing of trees tried more extensively."

On the formation of tamarisk groves.

3. *Experimental cultivation of Tamarisk.*—In my last report I recommended that trial sowings should be made of certain kinds of tamarisk, *viz.*, the *frásh* tree (Tamarix articulata), and a bushy kind called *jhan* (T. gallica). They both appear to thrive well in a saline soil. The former is very common in the neighbourhood of Lahore, and in other parts of the Panjab; and the bushy kind is abundant in the low-lying country about Delhi, where the soil is also impregnated with salts. I have been informed by the Assistant Director of Agriculture that 50 cuttings of the *frásh* tree were obtained from the Panjab in August last, but owing to delay in transit the most of them had lost their vitality before they reached their destination. Seeds were also tried, but they failed to germinate. It is not stated in what manner the seeds were sown, whether broadcast or in nurseries, and as to the cuttings, supposing that they had all survived, the number was far too small for the production of any reliable results. I therefore recommend that the same method be adopted for the formation of tamarisk groves on *usar* land as has been proposed in the case of the *dhák* tree. There ought to be no difficulty in raising a sufficient number of young plants to start with. The *jhan*, or shrubby kind, prefers damp low-lying ground, the plantation for it should, therefore, include land of this nature When once established it would spread of itself.

[The following articles in the *Dictionary* may be consulted in connection with the protection and encouragement of the growth of indigenous vegetation on salt-impregnated soils and sand drifts :—

Caltropis gigantea, *Vol. II.*, **C. 190.**
Sand-binding Plants, *Vol. III., Part II.*, **S. 774.**
Tamarix, *Vol. V. I., Part III.*, **T. 51-81].**

G. I. C. P. O.—No. 341 R. & A. D.—19-12-96.—1,100.—H. R.

(Vegetable Product Series, No. 28.)
(Fibres.)

THE

AGRICULTURAL LEDGER.

1896—No. 34.

AGAVE SP.

(SISAL HEMP.)

[*Dictionary of Economic Products, Vol. I.*, A. 631.]

Results of Examination of a Sample of Sisal Hemp Fibre at the Imperial Institute.

The information which follows is given as a supplement to *The Agricultural Ledger No. 18 of 1894* on **Agave.**

In acknowledging receipt of a sample of the fibre of **Agave rigida,** *Mill., var.* **sisalana,** submitted for opinion as to quality by the Superintendent, Government Botanical Gardens, Saharanpur, the Reporter wrote:—"The sample of Sisal hemp seems brittle, short, and to have lost in strength during preparation. In the present state of the European demand this fibre would, it is feared, not fetch a very high price. Aloe, Sisal, and other allied fibres are a drug in the market."

The quantity of fibre received was small, the produce of 2lb of green leaves only, but it was thought advisable to forward the sample to the Imperial Institute for favour of experts' opinion and a commercial valuation.

From information subsequently to hand from the Superintendent, Government Botanical Gardens, it appears that the plant has been under cultivation at Saharanpur only a few years, and that probably the leaves have not yet attained to maturity.

A. 631.

The matter was promptly dealt with by the Secretary and Director who replied as follows :—

From SIR F. A. ABEL, BART., K.C.B., *Secretary and Director, Imperial Institute, London, to* GEORGE WATT, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Calcutta,—No. 560—69, dated the 12th March 1896.*

I have the honour to acknowledge the receipt of the sample of Sisal fibre advised in your letter dated 5th February, 1896. The quantity sent weighs only 12 grammes and is insufficient for a complete chemical examination, but this will be carried out as far as is possible with the limited supply of material, and the results forwarded by next mail.

The sample has been sent to two Experts, both of whom remark on the short staple of the fibre. For fibre of the length and quality of the sample, the present market price would be from £14 to £15 per ton, at which rate a very large quantity could be sold. If, however, similar fibre could be obtained of greater length, the value would be considerably enhanced, and reach £17 to £18 per ton. Mr. C. E. Collyer, one of our Expert Referees for Fibres, is of opinion that a better material could be obtained, if attention were paid to the selection of plants for cultivation on suitable soil.

Sir F. A. Abel kindly supplemented his previous letter by another giving the results obtained from a chemical examination of the fibre.

From SIR F. A. ABEL, BART, K.C.B., *Secretary and Director, Imperial Institute, London, to* GEORGE WATT, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Calcutta,—No. 83—70, dated the 18th March 1896.*

In continuation of my letter, Flying Seal Series No. 82, dated March 12th, 1896, I have the honour to forward the results obtained from the chemical examination of the sample of Sisal fibre. For purposes of comparison, the results which are given below are arranged side by side with those furnished by samples of Sisal from Trinidad and from the Bahamas respectively. The fibre suffers somewhat more in the hydrolytic processes than the other fibres, otherwise there is but little difference between them. The quantity

of fibre sent was insufficient to admit of the carrying out of the "mercerising" and "acid purification" processes :—

	Trinidad Sisal.	Bahamas Sisal.	Indian Sisal.
Moisture, per cent.	11·6	12·8	11·2
Ash, per cent.	1 0	4·4	1·7
Hydrolysis (*a*), loss per cent.	11·7	12·0	13 4
Hydrolysis (*b*), loss per cent.	13·5	16·1	17·2
Nitration, gain per cent.	32·9	29·7	30 8
Cellulose, per cent.	77 2	75·9	78·8
Acid purification, loss per cent.	1·0	8 1	...
Mercerising, loss per cent.	8·9	13·4	..

These communications, were acknowledged by the Reporter in the following letter :—

From GEORGE WATT, Esq, M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Calcutta, to* SIR F. A. ABEL, BART., K.C.B., *Secretary and Director, Imperial Institute, London,—No. 1226—76 F.S., dated the 29th April 1896.*

I have the honour to acknowledge with thanks the receipt of your letters, Flying Seal Series, Nos. 79,* 82, and 83, dated 4th, 12th, and 18th March, 1896, respectively, on the subject of **Agave rigida** *var.* **sisalana.**

In reply thereto I beg to state that a copy of the report kindly furnished by you has this day been forwarded to the Superintendent, Government Botanical Gardens, Saharanpur, from whom the fibre was received. I also propose to issue these letters as a fly leaf of additional information to our *Agricultural Ledger* on **Agave.** I would take this opportunity, however, to observe that in a communication received from the Director of the Royal Botanic Gardens, Kew, a less sanguine view is taken of India's prospects in the **Agave** fibre supply than would seem justified by the valuations furnished by the fibre experts of the Imperial Institute.

* Acknowledging receipt of letter covering sample of fibre and promising action on arrival of the latter.

G. I. C. P. O.—No. 491 R. A.—30-11-96—2100—S J. D'S.

(Forest Series, No. 2.)
(Gums and Resins.)

THE

AGRICULTURAL LEDGER.

1896—No. 35.

ACACIA CATECHU.

(CATECHU, CUTCH, OR KATH.)

[*Dictionary of Economic Products, Vol. I., A.* 135 199.]

THE DYEING PROPERTIES OF CATECHIN AND CATECHU-TANNIC ACID.

By PROFESSOR J. J. HUMMEL *and* MR. REGINALD B. BROWN. *Contribution from the Clothworkers' Research Laboratory in the Dyeing Department of the Yorkshire College, Leeds. Reprinted from the Journal of the Society of Chemical Industry, No. 6, Vol. XV.*

The paper now reproduced is given in continuation of *The Agricultural Ledger No. 2 of 1895* and *No. 2 of 1896*.

As will be seen it very greatly amplifies the information there set forth.

The note may be fittingly introduced by the following letters from the Secretary and Director, Imperial Institute, by whom it has been obligingly furnished:—

From SIR FREDERICK A. ABEL, BART., K.C.B., F.R.S., *Secretary and Director, Imperial Institute, to* GEORGE WATT, ESQ., M.B., C.M., C.I.E., *etc., Reporter on Economic Products to the Government of India, Indian Museum, No. 1, Sudder Street, Calcutta,*—No. R334—1 (*F. S. S. No. 94*), *dated London, 28th July 1896.*

I have the pleasure to forward herewith, for the information of your Department, two copies of a paper on the Dyeing Properties of Catechin and Catechu-Tannic Acid, which has been communicated to the Society of Chemical Industry by Professor Hummel and Mr. Reginald Brown, the material for these researches having been supplied through the Imperial Institute by the Indian Government.

Anyone who has studied the literature having reference to the application of catechu, must have been struck by the fact that very contradictory statements appear in text-books as to which of the two chief constituents of this dyestuff plays the more important part in the dyeing process. **Origin of present inquiry.**

ACACIA Catechu.

Dyeing Properties of Catechin

This uncertainty led us to make experiments on the subject, especially as we had at command a sufficient quantity of pure catechin, which had been prepared in the Research Laboratory of the Dyeing Department, by Mr. A. G. Perkin and Dr. Setzer. Moreover, a number of samples of various Indian cutches had been received for examination from the Imperial Institute, and it was thought that the investigation of the dyeing properties of these samples and of the constituents of catechu in their pure condition might suitably be undertaken at the same time

Diversity of opinion regarding catechu as a tanning and dyeing material.

The authors of many text-books appear to have derived their information from an earlier source, for we find the same statements couched in identical language in several works, while in no case are the actual experiments described on which the conclusions are based. All agree in describing catechu as containing (1) a colourless crystallisable body insoluble in cold water, which is called catechin or catechuic acid; (2) a substance of the nature of tannin, perfectly soluble in cold water, and known as catechu-tannic, or mimotannic acid; and (3) other substances possessing a brown colour, and probably formed by the oxidation of one or both the preceding bodies, *e g* rubinic and japonic acids. Here agreement ends and as regards the usefulness of these substances in dyeing, a variety of views are expressed Kurrer (1848) states that the portion of catechu possessing dyeing properties is the catechin which, on oxidation, forms japonic acid, and that the catechu-tannic acid is without any influence on the production of the colour, since catechu from which all the catechu-tannic acid has been removed retains its dyeing properties unimpaired. The same statement, that catechin plays the chief part when catechu is employed in dyeing, is also made by Schetzenberger (*1867*), Fol. (*1872*), Crookes (*1874*), Singer (*1875*), and others On the other hand, the claims of catechu-tannic acid to be the useful constituent for the dyer are upheld by Saco (*1861*) and V. Joclet (*1879*), while Napier (*2nd Ed., 1875*), Girarden, and Crace Calvert (*1878*) ascribe the dyeing properties of catechu to both constituents

Object of present experiments.

In view of these contradictions, we decided to make dyeing experiments with the pure substances, having regard only to the application of catechu in the dyeing of cotton. The crystallised and colourless catechin prepared in the Research Laboratory was considered to be absolutely pure, and the catechu-tannic acid employed, obtained from the firm of E. Merck, of Darmstadt, though not absolutely pure, having a pale yellowish-brown colour, seemed to be sufficiently pure for the present purpose. In the first instance we merely compared the dyeing properties of these two products with each other, and at the same time with those of commercial Gambier and "Bull-cutch," as representing two widely different varieties of catechu. In the course of the experiments, however, further points of interest arose, notably the function of copper sulphate in the dyeing process.

In the ordinary method of dyeing cutch-brown on cotton, the material is steeped in a hot solution of catechu containing a small addition of copper sulphate, and subsequently allowed to remain in the bath as it cools. Without washing it is then treated in a boiling bath containing potassium bichromate, and for deep shades the dyeing and chroming operations are repeated. Our first experiments were carried out according to this process, and were conducted as follows:— 0·5 grm. of each substance was dissolved in distilled water, and the solution, with or without the addition of copper sulphate, diluted to 50 c.c. In this solution a piece of cotton cloth 3½ × 2½ in. in size, and weighing 0·5 grms., was boiled for one hour, and allowed to steep for one hour in the cooling liquor, then squeezed, and "saddened" in a bath containing 2 grms. $K_2Cr_2O_7$ per litre for 10 minutes at the boil. During these operations the boiling liquors were maintained at a constant level With half of each pattern the dyeing and saddening processes were repeated.

First Experiment.

Experiment I.—Catechin, catechu-tannic acid, Gambier and Bull-cutch were dyed simultaneously according to the above method, with the addition of 0·05 grm. $CuSO_4$ to each solution. On comparing the results it was seen that the shades given by catechin and Gambier were similar and much paler than those obtained from catechu-tannic acid and Bull-cutch, which were also similar to each other. The inferences to be drawn from this experiment are (1) that both catechu-tannic acid and catechin possess dyeing properties, but the former to a much greater degree than the latter; (2) that Gambier behaves in dyeing exactly like catechin, while Bull-cutch behaves like catechu-tannic acid. The repetition of the dyeing and saddening operations very greatly increases the depth of colour; in fact, only in this way is it possible, according to our experiments, to obtain very full brown shades, an increase in the concentration of the cutch bath not sufficing for this purpose. It may be noted in passing that catechin dyed twice gives a very similar shade to catechu-tannic acid dyed once.

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Experiment 2.—A repetition of Experiment 1 was made, omitting the addition of copper sulphate to the dye baths. A similar comparative result was obtained, but all the shades were much lighter than in the first experiment. In this trial Bull-cutch dyed a deeper colour than an equal weight of catechu-tannic acid, and since it is of course impossible that the commercial product can be stronger in actual colouring power, so far as this is due to catechu-tannic acid, than the pure substance itself, this greater depth of shade might seem to be due to the presence in the cutch of small quantities of other colouring matters. The varying tones of brown obtained from different cutches might also be accounted for in this way. Having regard, however, to the fact that when dyeing with the addition of $CuSO_4$ (in Experiment 1), the depth of colour produced by catechu-tannic acid is slightly greater than that given by cutch, it is possible, and appears to us more probably correct, that the greater colouring power of the cutch in this experiment is due to its containing certain soluble oxidation products intermediate between catechu-tannic acid and the insoluble brown colouring matter as fixed on the fibre.

It was noticed that catechin with copper sulphate produced a colour equal in depth to that given by catechu-tannic acid without this addition. It is therefore possible, as suggested by Neubauer (*1856*) that under the oxidising influence of copper sulphate catechin is converted into catechu-tannic acid, and since the experiments show that the latter when dyed with the addition of copper sulphate yields a darker colour than without, it would appear as if catechu-tannic acid formed an intermediate product between catechin and the ultimate brown substance fixed upon the dyed cotton.

Third to Sixth Experiments.

Experiments 3 to 6 were made with the object of ascertaining to what extent each step in the process contributes to the final depth of colour when dyeing with the pure colouring principles with and without copper sulphate. In each case one pattern was dyed for an hour at the boil, a second was allowed to cool in the bath, and with the third and fourth patterns the operations were repeated twice and thrice respectively. The patterns showed that the increase in depth due to steeping in the cooling liquor is very marked in the case of catechu-tannic acid but very slight with catechu; the latter is at once precipitated on cooling, and further absorption of it by the fibre is thus prevented. Catechin dyed without copper sulphate yields only a very pale brown, even after three times dyeing and saddening; after the first saddening the cotton has merely acquired a dull yellow tint, and it is possible that the colour resulting from repetition of the dyeing process may be due to catechin becoming partially changed in the dye-bath to catechu-tannic acid by atmospheric oxidation. In the case of catechin it is also noticed that the effect of

ACACIA Catechu.

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chroming at each stage of the process is to make the colour much yellower and only very slightly deeper; the increased depth of colour due to repetition of the operations is therefore acquired during dyeing and not in the saddening bath. With catechu-tannic acid the exact contrary is the case, an added dyeing operation merely makes the brown yellower in tone and very little fuller, while on saddening a great increase in depth results. It would seem therefore that the colouring matter in the form of catechu-tannic acid, which may provisionally be regarded as the more highly oxidised condition, is more sensitive to the further influence of oxidising agents, *e.g.*, $K_2Cr_2O_7$, than when it is in the form of catechin.

Results of First and Second Experiments confirmed.

It may be further noted than the results of these trials corroborate those of Experiments 1 and 2, the shades obtained by the use of catechin with the addition of copper sulphate, and catechu-tannic acid without this addition, are similar in depth, but the browns from catechin are redder before saddening and yellower after saddening than those from catechu-tannic acid.

Seventh Experiment.

Experiment 7.—Catechu-tannic acid and commercial Bull-cutch were dyed *in the cold* for periods of 1 and 16 hours without the addition of $CuSO_4$; it was here sought in feed to apply catechu-tannic acid to cotton under the conditions found most favourable in the case of tannic acid. On comparing the patterns with those of Experiment 2, which were dyed at the boil, it was seen that the shades differed little from each other. This result was by no means unlooked for since in the absence of $CuSO_4$ one would naturally expect that only the soluble catechu-tannic acid would be utilised. By allowing the patterns to steep in the dye-bath overnight, instead of for one hour only, a slight increase in depth results, and here again it is possible that atmospheric oxygen during the prolonged operation acts like the copper sulphate of the ordinary process.

Eighth Experiment.

Experiment 8.—Patterns were dyed under exactly the same conditions as in Experiment 7, but with the addition of $CuSO_4$ to each dye-bath. Here no improvement is shown on prolonging the dyeing operation beyond one hour, all possible oxidation in the dye-bath being apparently effected by the $CuSO_4$ during the first hour. On comparing the dyed patterns with those obtained in Experiment 1, dyeing at the boil, very little difference in depth of colour was noticed in the case of catechu-tannic acid, but with Bull-cutch which, of course, contains both catechin and catechu-tannic acid, the patterns dyed at the boil were considerably the deeper. This fact again indicates that in the presence of $CuSO_4$ both constituents of the cutch take part in the dyeing process.

Ninth Experiment.

Experiment 9.—It was thought possible that the greatly increased depth of colour caused by a repetition of the dyeing process was due to the attraction of further colouring matter by the chromic oxide fixed upon the cotton along with the colouring matter after once dyeing. In order to ascertain whether cotton mordanted with chromic oxide attracts the colouring matters of catechu, a piece of cotton was mordanted with chromium and divided into portions of the same size as those used in previous trials. These were dyed with catechin and catechu-tannic acid and saddened with $K_2Cr_2O_7$; the colours obtained in this trial were in both cases considerably deeper than those dyed on unmordanted cotton; the explanation suggested may therefore be the true one. With regard to the use of mordants in conjunction with cutechu, it was found that with aluminium mordants pure catechin dyes a dull light brown, and with iron mordants a more purplish brown, both colours becoming much yellower on subsequent treatment with with $K_2Cr_2O_7$. Catechu-tannic acid yields with aluminium a brownish-yellow, with iron a dull light brown, and these shades are made much deeper by saddening with $K_2Cr_2O_7$, the former changing to a full red-brown, the latter to a yellowish-brown of medium depth.

Action of copper sulphate.

There still remained to be considered the action of the copper sulphate in the dye-bath. If the idea is correct that it brings about the conversion of catechin into catechu-tannic acid, the question naturally arises: Is this change effected by virtue of the oxidising properties of copper sulphate, or is the presence of a metallic mordant in the dye-bath an essential feature of the operation? To solve this question, as far as it can be solved by dyeing experiments, it was necessary to dye with the addition of various substitutes for copper sulphate, some of which resembled this salt in containing a metal, others in possessing oxidising properties, and to compare the patterns so dyed with those dyed without addition and with the addition of copper sulphate. In choosing oxidising agents for this purpose, $K_2Cr_2O_7$ and ferric salts were necessarily excluded, since they precipitate catechin in the dye-bath. According to the result of the experiments, which were made with Gambier, the substitutes employed may be divided into three groups:

Substitutes for copper sulphate considered.

(1) Substitutes which yield no useful result, the resulting colour being little or no deeper than when dyed without addition. In this group are comprised chrome alum, aluminium sulphate, zinc sulphate, sulphuric acid, and sodium carbonate.

(2) Substitutes causing an increased depth of shade, but giving a duller and yellower shade of brown than that obtained with the use of copper sulphate. These additions were ferrous sulphate and potassium permanganate with sulphuric acid.

(3) The colour is somewhat similar in depth and tone to that given by dyeing with the addition of copper sulphate. This was the case with hydrogen peroxide only.

Conclusions.

We may therefore conclude from these results that copper sulphate is mainly useful on account of its oxidising properties, which, however, are not active enough under the conditions of the dye-bath to precipitate the solution. Non-oxidising metallic salts have little or no influence upon the shade, with the exception of ferrous sulphate, which resembles potassium permanganate in causing the production of a deep dull brown of a yellowish tone, a result probably due to a mordanting action of the iron and manganese respectively. Since, however, the pattern dyed with the addition of ferrous sulphate is lighter than the one obtained by the use of permanganate, the oxidising property of the latter is apparently not without influence on the depth of colour. The change in the dye-bath to which the increased depth is due is not brought about by either acid or alkali, and the only useful substitute for copper sulphate among those we have tried is peroxide of hydrogen, which, however, gives a shade somewhat lighter and redder in tone than is obtained by the use of copper sulphate. It has already been conjectured that in certain cases the oxygen of the air may act in the same way as the $CuSO_4$, although by reason of the slow action of the air the use of $CuSO_4$ could never be superseded in practice by atmospheric oxidation, at any rate, so far as *dyeing* with catechu is concerned.

Final Experiment.

A final experiment was now made to compare the effects of applying the copper sulphate and catechin *simultaneously* and *successively*, and for this purpose one piece of cotton was treated successively in separate baths with $CuSO_4$ and catechu, with a second pattern this order of operations was reversed, while two others were dyed at the same time with cutch alone, and cutch + $CuSO_4$ respectively; half of each pattern being afterwards saddened with $K_2Cr_2O_7$. On examining the patterns it was seen that the cotton treated with $CuSO_4$ and then with catechu was similar before and after saddening to that dyed without addition. As we expected, the preliminary boiling with $CuSO_4$ had no effect. On now comparing the results of applying the copper sulphate in the same bath as the cutch and subsequently to it, the former pattern was found to be

ACACIA Catechu.

Dyeing Properties of Catechin

much the deeper, and hence we conclude that the function of copper sulphate is to convert the colouring matter into some form in which it is most readily attracted by the cotton, and for this purpose it must be added to the actual dye-bath

Brief summary. The conclusions to be drawn from our experiments may now be briefly summarised as follows :—In dyeing cotton with catechu the catechin and catechu-tannic acid both contribute to the production of the colour, the tinctorial power of catechu-tannic acid exceeding that of catechin. It is very probable that in the dye-bath catechin is converted into catechu-tannic acid by the action of $CuSO_4$, and it is therefore clear that a two-fold oxidation is necessary, the addition to the dye bath of a small quantity of some oxidising agent, *e.g* , $CuSO_4$, which does not cause precipitation of the colouring matter, and a subsequent oxidation in a separate bath with potassium bichromate. Having regard to these facts, our experiments show that the practical method of dyeing with catechu, *viz.*, at the boil and with the addition of $CuSO_4$, is perfectly justified, for although the final product of the oxidation of catechin is the insoluble brown substance provisionally termed japonic acid, it does not appear that the oxidising action of the copper sulphate is energetic enough to produce this substance, already in the dye-bath. Had this been the case, the use of copper sulphate in the dye-bath would have been injurious. The final and complete oxidation to insoluble japonic acid is reserved for the subsequent action of the bichromate of potash.

Indian Cutch. In examining the dyeing properties of the 29 samples of Indian cutch received from the Imperial Institute, it became evident that the differences observed in the dyed patterns corresponded to a certain extent to the differences shown by catechin and catechu-tannic acid in the foregoing experiments. The cutch samples were compared in the following manner :—10 grms. of each sample were extracted with water at 80°—90° C. for one hour, 1 grm. $CuSO_4$ added, and a piece of cotton cloth weighing 10 grms. entered into the bath. The above temperature was maintained with constant level for one hour, and the cotton allowed to cool for four hours in the liquor; at the end of this period one-third of the pattern was retained without further treatment, the remainder saddened for 10 minutes at the boil in a bath containing 2 grms. $K_2Cr_2O_7$ per litre. At this stage another portion of the pattern was retained, and the remaining third of the original piece was subjected to a repetition of the dyeing and saddening operations.

Classification of samples of cutch. Judged according to their dyeing properties, the various samples of cutch examined naturally divide themselves into the following three groups :—

Group I. I. Cutches which, by the simple treatment of cotton in their decoctions at a high temperature, with the addition of copper sulphate, impart a more or less yellowish-brown and somewhat pale colour to the cotton, *not materially affected or darkened by subsequent boiling with bichromate of potash*, thus showing that little of the colouring principle of the catechu has been attracted by the cotton. If the two operations are repeated, these cutches give yellowish-browns possessing only a moderate depth of colour.

Group II. II. Cutches which in the first process stain the cotton a reddish- or orange-brown colour much fuller than that given by the members of Group I, and *which by chroming are rendered distinctly redder and darker*, an indication that the cotton has taken up a much larger quantity of the colouring principle than in the case of cutches belonging to Group I. By repeating the operations of "stuffing" and "saddening" the cutches of this group give a full rich reddish-brown dye much deeper than that given by the members of Group I. These cutches are apparently of the best quality for the purpose of cotton dyeing.

Group III. III. Cutches which in the first process give a comparatively pale yellowish-cinnamon colour, which is reddened by chroming. By repeating

the operations of "stuffing" and "saddening" these cutches give reddish-browns, having little depth or body of colour.

On examination it would appear that the first group includes cutches Nos. 1—8 (see table below) all of which are of a somewhat pale brownish-grey internally, and show an earthy fracture Nos. 9—12 may be reckoned as belonging to the same group, although they are dark brown in colour, show a lustrous fracture, and dye a somewhat redder shade of brown than the foregoing. From their appearance these cutches consist very largely of catechin.

The second group comprises Nos. 14—25, all of which are dark brown in colour, and have a lustrous fracture. These cutches being much more soluble in cold water than those of Group I, and giving darker colours, no doubt consist very largely of catechu-tannic acid. The third group includes the Gambier catechus, Nos. 26—28, which have a pale colour and earthy fracture, appearing to consist essentially of catechin.

In the table below, cutches Nos. 1—12 are arranged according to the shade given in dyeing cotton, No. 1 giving the yellowest brown, No. 12 the reddest shade.

Cutches Nos. 14—25 are arranged in order of depth of colour, No. 14 being the darkest and No. 25 the palest, though still a good colour.

Of cutches Nos. 26—28, the first mentioned gives the deepest colour.

Sample No. 13 gives only a grey stain and is evidently not catechu, but, as stated on the label, an imitation, and appears to consist chiefly of mineral matter.

No 29, which is not intended for dyeing, has similar properties to Nos 26—28, but gives a much paler colour of comparatively little value.

For the purpose of comparison, cotton patterns were also dyed with the two following samples of cutch at present in the market:—

Bull-cutch and Mangrove cutch compared.

1. *Bull-cutch*—This quality, which is said to represent the best in the market, has the form of large irregular blocks of a dark-brown colour and lustrous fracture.

2. *Mangrove cutch.*—This variety of cutch, which is probably derived from Ceriops candolleana, forms a very dark reddish-brown resinous mass, having considerable lustre, and being almost entirely soluble in cold water.

When dyeing with Bull-cutch the cotton is stained in the first operation a pale yellowish-brown, somewhat similar to that given by the members of Group I., but by chroming it became much darker and redder, behaving, therefore, like those of Group II. By repeating the stuffing and saddening operations a very full reddish-brown dye is obtained. The Mangrove cutch behaved during the dyeing process very similarly to the Bull-cutch, the chief difference being that in the first operation the cotton is stained a very much redder shade than that given by any other cutch examined. These dyeing experiments show that the Bull and Mangrove cutches may be considered as belonging to Group II.—indeed they may be placed at the head of this class, since after twice dyeing they give much darker colours than any of the rest.

On comparing the results obtained from the various catechus with those given by catechin and catechu-tannic acid it was seen that those catechus which are brown in colour, lustrous, and more soluble in water behave in dyeing like catechu-tannic acid, while those which are paler in colour, with earthy fracture and less soluble, behave like catechin, of which they probably largely consist. Since catechu-tannic acid possesses greater colouring power than catechin, it is evident that the cutches which are more lustrous, more soluble, and richer in catechu-tannic acid are the most valuable for the purpose of dyeing cotton.

ACACIA Catechu.

Dyeing Properties of Catechin

No.	Commercial Name.	Source.	Form.	Colour.	Fracture, etc.
1	Cutch Extract . .	Forest Department, Bombay.	Small paste-like pieces, flat on one side.	Dull pinkish-fawn . .	Brittle, with dull earthy fracture showing numerous minute white spots.
2	Cutch	Kumaun, N.-W. P. .	Small irregular or rectangular blocks.	Inside, dull pinkish-fawn; outside dark brown.	Tough, with earthy fracture showing laminated structure.
3	Cutch, superior quality. "Swat Catechu."	Chamber of Commerce, Bombay.	Similar to No. 1 . .	Similar to No. 1 . .	Similar to No. 1, but showing fewer white spots or none.
4	Cutch, Cawnpore catechu (superior quality).	Bombay . . .	Similar to No. 2 . .	Similar to No. 2 . .	Similar to No. 2.
5	Catechu Extract . .	Surat, Bombay . .	Similar to No. 1 . .	Similar to No. 1 . .	Similar to No. 1, but showing no white spots.
6	Cutch. *Var. Janakpuri*, No. 3.	Calcutta Market . .	Small pieces like coarse gravel.	Dark brown or fawn .	Lustrous fracture in dark portions; laminated structure.
7	Cutch. *Var. Janakpuri*, No. 2.	" "	Irregular lumps as if portions of slabs.	Outside dark brown; inside paler.	Brown parts lustrous fracture, the pale portions earthy; laminated.
8	Cutch *Var. Janakpuri*, No. 1.	" "	Similar to No. 7 . .	Similar to No. 7 . .	Similar to No. 7.
9	Cutch, called Val Pegu (*Salpatawala*).	" "	Rectangular slabs 6 × 3 ins., wrapped in leaves.	Reddish brown throughout with here and there darker spots.	Fracture only slightly lustrous, showing minute air spaces.
10	Cutch, Telengar, No. 1	" "	Irregular lumps . .	Outside light earthy brown; inside very dark brown.	Fracture lustrous, showing numerous air spaces.

and Catechu-Tannic Acid. (*J. J. Hummel and R. B. Brown.*)

11	Cutch. *Var. Belguti Kalogasan.*	" "	Rounded lumps, flat on one side.	Very dark brown, almost black.	Fracture irregularly dull and lustrous, showing here and there bits of lighter coloured vegetable matter.
12	Cutch, called imitation soft Burma.	" "	Similar to No. 11 . .	Similar to No. 11 . .	Similar to No. 11.
	Cutch. *Salpatawala* No. 3.				
13	Cutch. Imitation Rajapore catechu.	Bombay . . .	Somewhat similar to No. 11.	Dull earthy drab . .	Dull earthy fracture (evidently consists chiefly of mineral matter).
14	Cutch (hard) . .	Irrawaddy Div., Pegu Circle, Burma.	Large irregular blocks wrapped in leaves.	Very dark brown . .	Brittle, lustrous, with numerous air spaces.
15	Cutch (soft) . . .	" "	Similar to No. 14 . .	Similar to No. 14 . .	Similar to No. 14.
16	Cutch (black) . .	Minbu Div., Pegu Circle, Burma.	Large flat slabs wrapped in leaves.	" "	" "
17	Cutch (soft) . .	Yaw Div., Pegu Circle, Burma.	Small pieces like coarse gravel.	Very dark brown . .	" "
18	Cutch called Pegu No. 1.	Calcutta Market; imported from Burma.	Large flat slabs wrapped in leaves.	Dark brown . . .	" "
19	Cutch (yellow) . .	Pegu Circle, Burma	Small lumps, flat on one side, with leaf adhering.	Externally, light reddish brown; internally, darker.	Very brittle. Lustrous fracture somewhat porous.
20	Cutch (yellow) . .	Minbu Div., Pegu Circle, Burma.	Small rectangular slabs wrapped in leaves.	Dark reddish-brown .	Brittle. Lustrous fracture, numerous air spaces.
21	Cutch (red) . . .	"	Similar to No. 20 . .	Similar to No. 20 . .	Similar to No. 20.

Note.—Nos. 1 to 25 are derived from the Acacia Catechu and 26 to 20 from the Unacaria Gambier.

ACACIA Catechu.

Dyeing Properties of Catechin

No.	Commercial Name.	Source.	Form.	Colour.	Fracture, etc.
22	Cutch (manufactured in iron pots).	Benghari Darrang Div., Kamrup, Assam.	Large slabs, wrapped in paper.	Dark reddish-brown .	Similar to No. 20, but without air spaces. Dense and compact in structure.
23	Cutch (manufactured in brass pots).	" " .	Similar to No. 22 . .	Similar to No. 22 . .	Fracture earthy, except in the outer portions, which are darker in colour and lustrous; dense and compact in structure.
24	Cutch (black) . .	Pegu Circle, Burma .	Small blunt cones wrapped in leaves.	Very dark brown, almost black.	Fracture highly lustrous, with numerous air spaces; brittle.
25	Cutch (hard) . .	Yaw Div., Pegu Circle, Burma.	Irregular lumps . .	Very dark brown . .	Very brittle, fracture lustrous, very numerous air spaces; almost cindery.
26	Cube Gambier (No. 1 best form).	Singapore . . .	Small cubes . . .	Externally, pale brown; internally, buff.	Brittle, fracture earthy.
27	Cube Gambier (No. 2 best form).	" . . .	Similar to No. 26 . .	Similar to No. 26 . .	Similar to No. 26.
28	Block Gambier . .	" . . .	Irregular lumps . .	Outside, dark brown; inside, paler.	Fracture of outer portion of blocks, lustrous; of inner portion, earthy and powdery.
29	Gambier Papan (used for chewing).	Negri Semblian . .	Thin square cakes .	Externally, pale brown; internally, buff.	Very brittle, fracture earthy, showing brownish specks as if mixed with foreign matter.

Note.—Nos. 1 to 25 are derived from the Acacia Catechu and 26 to 29 from the Unacaria Gambier.

A. 135-199.

These notes must be regarded as a very partial inquiry into the application of catechu in dyeing, since we have entirely omitted any reference to the details connected with the use of potassium bichromate as the saddening agent, but this, and other points of interest concerning the use of catechu, we may possibly refer to in a future communication to this Society.

Note by Acting Editor.

With regard to the composition of Indian samples of cutch, reference may be made to *The Agricultural Ledger No. 1 of 1895.* Analyses of two varieties of catechu, 26 and 29 in the foregoing list, were made by T. S. Dymond, F. I. C., in 1888. The Gambier Papan was imported into London for the first time about ten years ago. It was a variety of pale catechu in square plates, each piece measuring 54 mm. square and 3 mm. in thickness. It was derived from Malacca, where it was used by the Malays for mixing with betel for mastication. It was examined side by side with a good sample of cube catechu (26) to determine its comparative value, and the following were the results of the analysis :—

	Cubes.	Plates.
Catechu-tannic acid	24·9	34·70
Catechin	48·9	32·65
Insoluble residue	3·9	7·70

G. I. C. P. O. No. 1794 R. & A—8-4-97—100—A.McL.

(Animal Product Series, No. 1.)

THE AGRICULTURAL LEDGER.

1896—No. 36.

PEARLS AND PEARL FISHERIES.

(SEED PEARLS.)

[*Dictionary of Economic Products, Vol. VI., Pt. I.*, P. 355-60.]

PEARL FISHING IN THE BASSEIN DISTRICT.

Account of a Pearl Fishery near Cape Negris, including reports obtained on a small parcel of the pearls forwarded for opinion by the Burma Administration.

Early in 1895 the Burma Administration forwarded to the Reporter on Economic Products to the Government of India a small parcel of pearls and shells found near Cape Negris, Bassein District, and requested that these might be reported on by an expert and a copy of the report so obtained supplied.

The specimens were accompanied by a report from the Deputy Commissioner, Bassein, forwarded by the Commissioner of Irrawaddy through the Financial Commissioner on the subject of fishing for these pearls. The report is based on information obtained on the spot by the Deputy Commissioner from the Taik-thugyi Maung Naung and the Hainggyi villagers.

Vernacular names of the shell.

The shells are stated to be smaller than the mother-of-pearl shell and are known in Talaing as *chat-pya*, the Arakanese term being *thapya*.

It is said that they are gathered at low tide in shallow water either near the bank or on a shoal further off the shore.

The inhabitants of the neighbouring coast consist of Burmans, Talaings, Karens, and Arakanese. According to these villagers the

PEARL FISHERIES.

practice of gathering the shell for its contents as an article of food has obtained for many years.

That the small pearls sometimes found in the shells were pearls or that these possessed any market value was not known to the villagers, so it is stated, until interest was aroused by Natives of India who a few months since came and inquired for them.

The manner of obtaining the pearls is thus described. At spring or neap tides the shells lie in a cubit or so of water. At high tide they lie 4 to 5 cubits deep, when it is necessary to dive for them.

The shells are gathered with the hand. Ordinary boats are used and no special equipment is necessary.

It is believed that beds of this shell-fish have existed for many years, probably from time immemorial.

After about five years beds have been noticed to disappear from one locality and to appear elsewhere. According to some informants on the first appearance of a bed the shells are small after which they slowly increase in size year by year. Others state that in a new bed both large and small shells are found.

Conf. p. 5.

The pearls are reported to be produced inside and round the body of the fish, but not inside the shell. It has been ascertained that the pearls burst if held in a flame. From the inquiries instituted there seems no reason to suppose that larger pearls than those composing the sample are ever met with.

The beds of pearl shells at present known occur at Hainggyi, Bondawbyit Thekkethaung and Thabyachaung in the Ngayotaung Circle. Others will probably be found to exist elsewhere.

The industry of pearl fishing in this locality is apparently of recent growth and is stated to have commenced only a few months ago. The people of the district have been employed by Natives of India to collect the shells, open them and remove the pearls. For this they have received for gathering at the rate of R4 per 10,000 shells, and R1-8 to R2 for opening them. The shell-fish after being collected are allowed to remain four or five days to decompose when the pearls are removed. Owing to the offensive odour which arises from the decayed fish, the task of collecting the pearls from the shells in this condition is said to be an extremely unpleasant one.

Collecting shells and removing pearls.

Prices paid.

Besides the system of contract labour just mentioned, the pearls are collected and sold by the Burmese to Natives of India. The prices

thus realised for pearls have risen from R2 per tical* weight to R3 per tola† weight: they have finally risen to R4 and R5 per rupee (tola) weight.

PEARL FISHERIES. Prices realised for pearls.

The average find of pearls is reported to be $4\frac{1}{2}$ to 6 ticals weight, or, say, $2\frac{1}{2}$ to $3\frac{1}{2}$ ounces (Av.), per 10,000 oysters gathered. From the information thus obtained, which the Deputy Commissioner believes to be trustworthy, it appears that the trade is a new one. Large pearls, it would seem, are seldom, if ever, met with.

Average yield.

Since it was feared that the oyster beds, if worked constantly, would soon be exhausted, the Deputy Commissioner issued a provisional order forbidding the collection of the shells. It was anticipated, however, that some difficulty would be found in enforcing the order.

The Deputy Commissioner suggested that, as the shell-fish sometimes lie along the banks frequented by turtles, collection of the shells at night within the limits of a turtle bank should be forbidden since, if permitted, the turtles would probably be thereby disturbed. He added that he did not think that a royalty could be levied owing to the difficulty in checking the weight of these small pearls.

Inadmissibility of pearl fishing off turtle banks.

The Deputy Commissioner was of opinion that perhaps the best way for Government to realise a revenue would be to sell the monopoly of gathering the shells by auction.

The Financial Commissioner in forwarding the report to the Executive Government mentioned that the highest offer which had been hitherto made for a year's license to work the fisheries was R1,500. He pointed out that the recoupment of the licensee to that amount involved on an estimate the destruction of half a million of oysters, and that it, therefore, seemed *primâ facie* preferable to forbid the collection of pearls altogether. It appeared, however, from the Deputy Commissioner's report that it would not be possible to prevent collection.

Remarks by the Financial Commissioner.

In Mr. Jardine's report on the Pearling banks it is stated that in Mergui a close season was unnecessary, because the divers were unable to work during the monsoon. But as the monsoon will not affect the work in the rivers and creeks,

* 1 tical = 252 grains troy = '57 oz., Av.
† 1 tola = 180 „ „ = '41 „ „

PEARL FISHERIES.

of the district of Bassein, the Financial Commissioner suggested that it would be well to require the lessee to cease operations between the months of May and October. He further suggested that the lessee of the pearl fisheries should not be given any right to gather shells over the turtle banks. Such an arrangement would be unworkable, and it would seem desirable to put up to auction the right to collect pearls with the right to work the turtle banks.

Close season desirable.

The Financial Commissioner accordingly recommended—

(*a*) that the right to collect pearls elsewhere than on turtle banks within defined limits be put up to auction;

(*b*) that the license should run for one year only;

(*c*) that the area within which pearls are found be divided into blocks by the Commissioner, but that the river area and the open sea area be not included in the same block;

(*d*) that an attempt be made to enforce a close season—say from May until October;

(*e*) that the lessees of the turtle banks be offered for a consideration to be decided by the Deputy Commissioner the right to collect pearls on the turtle banks;

(*f*) that in future the right to collect pearls be put up to auction with the right to work the turtle banks.

On their arrival in Calcutta the sample pearls in question were submitted to an expert who furnished the following report:—

Expert's report.

"Seed pearls such as you send can be sold at from R10 to R20 per tola (= 180 grains troy or ⅜ oz. Av.) according to lustre and shape. It is a little difficult to report on such small parcels as you sent, but so far as I can learn the following may be taken as about their value. You will observe that I have numbered all the lots:—

No. 1 has best lustre of all and would sell at about R20 per tola.

Nos. 2 and 3 appear much the same, and would fetch about R15 per tola.

No. 4 is worth about R10 per tola.

There is always a ready sale for such pearls."

Opinion of Dr. Alcock.

Surgeon-Captain A. W. Alcock, Superintendent of the Indian Museum, who had paid considerable attention to the subject in its scientific aspects was also consulted. **Dr. Alcock** was not very

PEARL FISHERIES.

sanguine as to the ultimate success of this pearl fishery. He remarked :—

Dr. Alcock's report.

"The shells are **Placuna placenta.** The pearls which **Placuna** yields are not worth much; they are like the pearls of **Tridaena** and **Ostraea** which I have myself taken when with the *Investigator* only of use to excite false hopes. Many species of **Lamelli-branchia** yield pearls, but only those of **Meliagrina** (the true Pearl Oyster) and of the freshwater mussels ('Scots pearls') are worth anything. In my opinion it would be unwise to interfere with the poor people who collect **Placuna,** for it is a common species throughout the seas of India and China, and nothing that a handful of Burmese can do is likely to affect its existence in any way; nor in my opinion would the fishery interfere with the turtles, for **Placuna** likes a muddy bottom, whereas turtles prefer reefs."

In response to an inquiry for any later information on the subject, the Revenue Secretary to the Chief Commissioner, Burma, forwarded copy of a letter from the Deputy Commissioner, Bassein, No. 1639—88, dated the 31st August 1896, in which the writer stated that no fresh particulars of a trustworthy kind had transpired, and that the reports to hand regarding the industry could not be verified until after the rainy season in November or December. The Deputy Commissioner added :—It is said that large pearls are to be found in abundance in deep water off Diamond Island, also that the supply of the oyster in which the small pearls occur is nearly exhausted by last year's operations. The evidence regarding the yield of pearls last year was conflicting. It was reported that 2,000 tolas of small pearls were taken from two stations. Since about 20,000 oysters produce only one tola, the Deputy Commissioner estimates the number of oysters taken at about 40 millions.

Conf., p. 8.

It would appear from the Deputy Commissioner's letter that the supply of small pearls is almost exhausted since when the blocks were put up to auction some two months previously, only one found a purchaser at a reasonable rate.

P. 355-60.

G. I. C. P. O.—No. 508 R. & A.—8-12-96.—2,100.—H. R.

(Vegetable Product Series, No. 29.)

(Fibres.)

THE AGRICULTURAL LEDGER.

1896—No. 37.

CORCHORUS SP.

(JUTE.)

[*Dictionary of Economic Products, Vol. II.*, C. 1839.]

METHODS OF HARVESTING JUTE AND PREPARING IT FOR THE MARKET.

Result of Examination in the Research Department of the Imperial Institute (1) with the view to ascertain the best period for harvesting Jute so as to secure the highest quality of Fibre; (2) to discover a means of protecting the fibre against fermentation and other changes to which it is liable during transport.

The present inquiry of the Imperial Institute regarding Jute which is described in these pages may be said to have originated with the following F. S. S. letter from the I. I.:— Origin of the inquiry.

From SIR F. A. ABEL, BART., K.C.B., *Secretary and Director, Imperial Institute, to the Secretary to the Government of India, Department of Revenue and Agriculture,—No. 59—49 R., dated London, the 13th July 1894.*

I have the honour to inform you that the Sub-Committee for Fibres in the Department of Scientific and Practical Research of the Imperial Institute are desirous of investigating certain points of practical value with regard to jute fibre. Imperial Institute.

With this view, the Sub-Committee will be glad to receive a few small samples of jute fibre treated as follows:—

(1) Fibre from stems cut and retted at different periods, the yield in each case being noted. Descriptions of specimen desired.

(2) Fibre treated immediately after retting by steeping in a cold solution of sulphite of soda (2 per cent.), squeezing out the liquid and drying.

(3) Fibre boiled in a weak solution of carbonate of soda or in water with wood ashes, washed and dried. Portions of the

IMPERIAL INSTITUTE.

Inquiry on Jute.

• parcels of fibres, which are treated as at (2) and (3), to be sent in the untreated condition, for comparison.

I shall be glad if you can undertake the supply of the samples treated as suggested by the Sub-Committee, who will furnish a report on the result of their investigation.

Action taken on I. I. letter.

As soon as possible after the receipt of this letter the necessary arrangements were made to carry out the three experiments therein indicated.

The season was, however, then too far advanced for experiments with the plant in its early stages of growth. In reply to a letter from this office the Director of Land Records and Agriculture, Bengal, expressed his inability owing to lateness of the season to assist in the required experiments which involved preparation beforehand and the careful attention of a responsible officer. The Director stated, however, that he would endeavour to arrange for such experiments being made next year (1895). The work, which involved much labour and a good deal of expenditure, was accordingly entrusted to a respectable native to carry out under the personal supervision of Mr. T. N. Mukharji, Assistant Curator, Economic and Art Section, Indian Museum.

The following F. S. S. letter No. 37 is here given with reference to paragraph 3, in which comparison is made of certain samples of Sida fibre to jute. It may be explained that beyond dealing with the same subject the letter bears no relation to the present inquiry.

Fibres of Sida and Jute compared.

From SIR F. A. ABEL, BART., K.C.B., *Secretary and Director, Imperial Institute, to the Secretary to the Government of India, Department of Revenue and Agriculture,—No. 168—54, dated London, the 11th December 1894.*

I have the pleasure to forward you, for the information of your Department, the results obtained by the chemical examination, in the Research Department of the Institute, of the series of samples of Sida fibre included in the Indian Collections, and specified in the appendix of Hand-book No. 4 of the Imperial Institute Series. The system of examination pursued is that elaborated by Messrs. Cross & Bevan, and applied by them to the comparative examination of a number of fibres, the results of which have been published.

For purposes of comparison, I have included in the annexed tabular statement the results obtained by Messrs. Cross & Bevan

SIDA AND JUTE FIBRES COMPARED.

in the examination of a sample of jute fibre, as given in Mr. Cross's Report of Miscellaneous Fibres, included in the Colonial and Indian Exhibition (see Colonial and Indian Exhibition Report, page 372).

It will be seen that all the samples of sida are superior to jute. They are not, however, in any one instance quite as good as the specimen of sida fibre examined by Messrs. Cross & Bevan, the results of which are given in the place above cited.

Statement showing results obtained by the chemical examination, in the Research Department, of the series of samples of **sida** *fibre specified in appendix to Imperial Institute Hand-book No. 41.*

	Moisture in original fibre.	Ash in dried fibre.	Cellulose in dried fibre.	Loss by Hydrolysis treatment (*a*).*	Loss by Hydrolysis treatment (*b*).*	Loss by mercerising (1 hr.)†	Gain by nitration.	Loss by acid purification.	Length of ultimate fibre.
I.—Sida rhombifolia, *var.* rhomboidea.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	M. M.
a. From Cossipore Institution after 10 days' steeping.	14·	1·2	74·4	10·4	22·1	11·8	7	1·7	2—3
a. From Cossipore Institution after 16 days' steeping.	12·8	1·1	77·2	9·8	11·2	11·9	28·8	3·6	2—3
From Rahuta, Bengal.	12·7	1·6	79·3	8·7	14·5	13·2	32·2	1·9	2—2·5
c. From Rajshahi, Bengal.	12·7	1·4	76·2	11·2	14·8	10·3	27	3·3	1·5—2·6
II.—S. carpinifolia.									
From Nellore, Madras.	11·2	1·8	78·8	8·5	14·5	8·4	35·7	3·3	1·5—2·5
III.—S. cordifolia.									
From the Panjab .	12·7	1·5	78·5	10·8	14·5	10·91	29·9	1·9	1·5—3·
Jute (for comparison)	10·3	1·2	75·	15·	18·	16·	25	1·0	1·5—3

NOTES.—* *Hydrolysis* is the treatment of the fibre for five minutes, and one hour (respectively) with a boiling weak solution (one per cent.) of caustic alkali.

† *Mercerising* consists in treatment of the fibre with cold solution of caustic alkali (33 per cent.).

IMPERIAL INSTITUTE.

Examination of samples taken from the collection in the Indian Section.

On the subject of experiments with jute a further letter was received from Sir F. A. Abel, as under:—

From Sir F. A. Abel, Bart, K.C.B., *Secretary and Director, Imperial Institute, to the Secretary to the Government of India, Department of Revenue and Agriculture,—No. 479—56, dated London, the 21st February 1895.*

Conf, p 8.

In continuation of correspondence ending with Flying Seal Series, No. 37, dated 11th December 1894, I have the honour to forward herewith the results of the chemical examination, in the Research Laboratory of the Imperial Institute, of five samples of jute taken from the collection in the Indian Section.

A comparison of the figures in the accompanying table reveals a remarkable difference in the quality of the fibres examined, as evidenced by the variable amount of cellulose they contain, which ranges from 70 to 79 per cent. in different samples.

The results have been shown to Mr. Cross (of Messrs. Cross & Bevan), a member of the Committee of Advice of the Research Department, and that gentleman has suggested that, as the variation in quality as well as in price of jute is often considerable, it would be valuable if, in the interests of the Indian jute industry, the Government of India could institute experiments on the *growing crops* with the view to ascertain, if possible, the best period for harvesting jute, so as to secure the highest quality of fibre. The following is suggested as the line which experiments might, perhaps, conveniently follow, and in which the Imperial Institute might be able to co-operate with the Revenue and Agricultural Department:—

Further Experiments suggested.

(1) Specimens might be cut at the flowering period and every ten days after, and the stems forwarded to the Imperial Institute for examination. If this could be carried out on a sufficiently large scale to admit of spinning the fibre obtained from the stems, so much the better.

(2) The green weight of the entire stem and the yield of fibre might be determined in the samples cut.

(3) Short pieces of the stem, cut about 3 feet from the ground, at the stages mentioned in (1), might be forwarded in spirit for microscopic examination.

(4) Enquiry might be instituted as to whether any attempts at artificial selection had been made by jute growers, and experiments undertaken, if possible, in this direction.

The Imperial Institute will gladly render such aid as is in its

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power in order to further the object of these or similar experiments and to assist in carrying them to a successful issue.

With regard to the Sida fibres, the chemical examination of which has been reported to the Government of India in the letter above quoted, it is noteworthy that the chemical examination of these samples of jute when compared with the results obtained with Sida fibres again shows the superiority of the latter fibre. The Sida fibres, however, show a good deal of reticulation, which may possibly be the result of a tendency in the uncultivated shrubs to branch; and if this be so, the important question, as to whether such a tendency may not be counteracted by a system of cultivation directed especially towards this object, is one which might be worth the consideration of the Government of India.

Results of Chemical Examination of five Samples of Jute.

Conf., p. 4.

I. I. No.	Invoice No.	Whence received.	Description.	Moisture.	Ash.	Hydrolysis. (a)	Hydrolysis. (b)	Cellulose.	Mercerising.	Nitration.	Acid purification.
				P. c.	P. c.	P. c.	P. c.	P. c.	P. c.	P. c.	P. c.
215	214	Agricultural Department, Calcutta.	B. F. Extra B. quality.	11·1	1·0	8·5	12·5	79·0	10·3	37·5	1·9
2329	1125	Rajshahi District, Bengal.	Called Amnahimita.	10·6	0·93	7·6	11·5	75·5	9·5	37·4	2·2
211	210	Agricultural Department, Calcutta.	S. B., Medium roots cut.	10·4	2·	11·6	17·5	70·0	10·5	35·7	1·3
214	213	Ditto.	R. B., Extra fine. T. 4 quality roots cut.	9·6	0·7	9·1	13·1	77·7	8·5	36·7	2·0
222	221	Ditto.	R. B., Low quality. 3 roots uncut.	11·0	0·87	13·2	16·1	71·4	9·2	36·6	2·6

Notes on results of experiments carried out in Bengal.

The following notes by Mr. T. N. Mukharji embody the results obtained from the experiments I., II., and III. performed in compliance with the F. S. S. letter from I. I., No. 26, dated 13th July 1894:—

Experiment with Jute in accordance with the Imperial Institute Flying Seal Series No. 26, dated London, 13th July 1894, made at Rahuta, a village 20 miles north of Calcutta.

EXPERIMENT No. I.

To ascertain the quality of the fibre extracted from plants in different stages of growth.

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RESULTS OF EXPERIMENTS WITH JUTE

1.—Cut before flowering.

A field of jute sown in April was selected for the purposes of these experiments.

12th August.—400lb in weight of the stalks (bared of leaves) cut before flowering. The plants were then 6 feet high. Sample No. 5216.

Kept stacked for four days to allow the stems to ferment and the leaves to fall off.

16th August.—Steeped in water for 14 days.

30th August.—Washed and fibre extracted.

Yield 24lb. Fine, soft and silky fibre. Sample No. 5217.

2.—Cut just after budding.

5th September.—400lb of stalks cut. Sample No. 5218.
Stacked for four days.
9th September.—Put in water. Steeped for 20 days.
29th September.—Washed and fibre extracted.
Yield 29lb. Quality inferior to above. Sample No. 5219.

3.—Cut when in flower.

14th September.—400lb of stalks cut. Sample No. 5220.

Stacked for four days.

18th September.—Put in water. Steeped for 22 days.

10th October.—Washed and fibre extracted.

Yield 26lb. Quality still coarser. Sample No. 5221.

4.—Cut when in pod.

24th September.—400lb of stalks cut. Sample No. 5222.

Stacked for four days.

28th September.—Put in water. Steeped for 21 days.

19th October.—Washed and fibre extracted.

Yield 26 lbs. Quality like the above. Sample No. 5223.

This is the usual time for cutting the plants in this part of the country.

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5.—Cut when the plants were fully matured.

12th October.—400lb of stalks cut. Sample No. 5224.
Stacked for four days.
16th October.—Put in water. Steeped for 22 days.
7th November.—Washed and fibre extracted.
Yield 26lb. Inferior quality. Sample No 5225.
Such plants are reserved for seed only.

EXPERIMENT No. II.

To ascertain the result of treating jute with carbonate and sulphate of soda.

Sample No. 5226.—Jute fibre, 40lb extracted at the time usual with the cultivators (*i.e.*, when in pods), taken just after washing, and kept aside for comparison with the same kind of fibre treated with carbonate of soda. Drying, the fibre weighed 13½lb.

1.—Carbonate of Soda.

Sample No. 5227.—40lb of wet jute taken from the same heap as above, put in 33 gallons (25 seers=50lb) of water, in which 1lb of carbonate of soda was dissolved, gradually raised to boiling point; when taken down, the water wrung out and dried without any further washing. Yield 15lb of dried jute. Treated with carbonate of soda, it assumed a reddish colour. This was at first supposed to be due to the iron vessel in which the jute was heated. The experiment was tried in a small way in an earthen vessel: result the same reddish colour.

Sample No. 5228.—40lb of wet jute taken from the same heap put in above quantity (25 seers) of *boiling* water, in which 1lb of carbonate of soda was dissolved, and kept boiling for 20 minutes. Yield 14½lb dried jute. Colour reddish.

2.—Sulphate of Soda.

Sample No. 5230.—40lb of wet jute steeped for ten minutes in the above quantity (25 seers) of cold water in which 1lb of sulphate of soda was dissolved. Yield 15¾lb of dry jute. Colour not changed. [Sample No. 5229 is like No. 5226 jute untreated with any chemicals, kept apart for comparison with those that are so treated.]

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RESULTS OF EXPERIMENTS WITH JUTE.

Sample No. 5231.—40lb of wet jute steeped for half an hour in another solution like the above. Yield $14\frac{1}{2}$lb. Colour slightly reddish.

EXPERIMENT No. III.

To ascertain the result of treating jute with alkaline ashes.

1.—Plantain ash.

Sample No. 5232.—40lb of wet jute put in above quantity (25 seers) of cold water, in which $3\frac{1}{8}$lb of plantain ash was dissolved, gradually raised to the boiling point; when taken down, washed in clean water and dried. Yield $13\frac{1}{16}$lb of dried jute. Colour reddish.

Sample No. 5233.—40lb of wet jute put in above quantity (25 seers) of *boiling* water, in which $3\frac{1}{8}$lb of plantain ash was dissolved, kept boiling for 20 minutes, taken out, washed and dried. Yield 15lb of dried jute.

2.—Tamarind ash.

Sample No. 5234.—40lb of wet jute put in above quantity (25 seers) of cold water, in which $3\frac{1}{8}$lb of tamarind wood-ash was dissolved, gradually raised to boiling point; when taken down, washed and dried. Yield $11\frac{1}{4}$lb of dried jute. Colour reddish.

Sample No. 5235.—40lb of wet jute put in above quantity (25 seers) of *boiling* water, in which $3\frac{1}{8}$lb of tamarind wood-ash was dissolved, kept boiling for 20 minutes, taken down, washed and dried. Yield $12\frac{1}{4}$lb of dried jute. Colour reddish.

3.—Babul (Acacia arabica) *wood-ash.*

Sample No. 5236.—40lb of wet jute put in above quantity (25 seers) of *cold* water, in which $3\frac{1}{8}$lb of *babul* wood-ash was dissolved, gradually raised to boiling point, taken out, washed and dried. Yield $11\frac{3}{4}$lb of dried jute. Colour reddish.

Sample No. 5237.—40lb of wet jute put in above quantity (25 seers) of *boiling* water, in which $3\frac{1}{8}$lb of *babul* wood-ash was dissolved, kept boiling for 20 minutes, taken out, washed and dried. Yield $12\frac{1}{8}$lb of dried jute.

NOTE.—The inequality in the weight obtained after drying the 40lb of wet jute in each case seems to be due to the inequality in the amount of water held in suspension by each bundle of the wet fibre.

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On the 7th May 1895 a letter, F. S. S. No. 1, was addressed to the Secretary and Director I. I. in which the despatch of specimens of jute was advised as per printed list which accompanied them.

To that letter reply was received as follows:—

From Sir F. A. Abel, Bart., K.C.B., *Secretary and Director, Imperial Institute, to* George Watt, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Calcutta,—No. 142—61, dated London, the 28th May 1895.*

I have to acknowledge, with many thanks, the receipt of yours of the 7th May, forwarding copies of an account of the experiments instituted with jute. in accordance with the suggestions contained in my letter of the 13th July 1894, and I note that the specimens obtained as the results of those experiments have been forwarded to the Imperial Institute.

I regret to observe that, in connection with experiment No. 2, the *sulphite* of soda prescribed in my letter for use in the second part of that experiment appears to have been misread for *sulphate* of soda. The treatment of jute with *sulphite* of soda was suggested with a view to ascertain whether its bleaching properties might have any effect upon the quality of fibre yielded. Sulphate of soda being an inert salt is not likely to have furnished any important result. Should a supply of sulphite of soda be available, I would venture to suggest that this particular experiment, *i.e.*, comparison of the treatment of jute with carbonate of soda and sulphite of soda, might be carried out when opportunity offers.

This communication was acknowledged by F. S. S. No. 9, dated the 13th July 1895, and a promise was made that specimens of jute treated with sulphite of soda would be furnished as soon as ready.

Sir F. A. Abel's reply:—

From Sir F. A. Abel, Bart., K.C.B., *Secretary and Director, Imperial Institute, to* George Watt, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Calcutta,—No. 486—64, dated London, the 17th September 1895.*

I have to acknowledge, with many thanks, the receipt of your letter of the 13th July, Flying Seal Series No. 9, No. 793—XVI-69, in which you inform me that steps will be taken this season to treat a sample of Jute with "Sulphite of Soda" for purposes of examination in the

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Research Department, in comparison with the samples of specially treated fibre already received.

I would suggest that as this prepared fibre will be of a different season's growth from the series sent in May last, it will be desirable to have a sample of the untreated jute sent, and also a sample of the same material treated with carbonate of soda, together with the product of the sulphite of soda treatment.

I have now the pleasure to forward the first report upon the results of experiments with some of the samples of jute referred to in your letter of the 7th May, Flying Seal Series No. 1—450. The second report will be sent as soon as we have been enabled to examine the sample of fibre treated with sulphite of soda which you are proposing to send, and which will be compared with the other specially-treated fibres now under examination.

I shall be glad to know, in reference to the accompanying report, whether it is considered practicable to carry out an experiment of the kind suggested therein, the result of which would probably add importantly to the information obtained by the series of experiments which we are carrying on.

SOME EXPERIMENTS ON INDIAN JUTE.

FIRST REPORT.

Introductory.

In order to make clear the reasons for the investigations here recorded and the objects in view, a few preliminary remarks on the nature of the material under examination are considered advisable.

Cellulose.

The substance cellulose, of which ordinary cotton is an almost pure form, is characterised by extraordinary chemical stability and is not susceptible of attack by other than powerful chemical agents.

Ligno-cellulose.

Cotton is thus able to withstand remarkably well changes in temperature, variations in exposure to the action of moisture, to the oxidising effects of sunshine, to commercial preparative processes to which it is subjected, and to other influences tending to promote chemical change; in other words, it does not readily rot.

The best fibres of the two species of Corchorus which constitute the jute of commerce consist, not of pure cellulose, but of an allied substance known as lignocellulose. This is a compound much

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more susceptible of chemical change than cellulose, and therefore readily acted on by comparatively feeble chemical agents.

The most generally accepted view of the difference between the two materials is, that lignocellulose results from the overlaying of normal cellulose by non-cellulose matters, comprehended under the term "lignone." Experience shows that pure cellulose fibres are characterised by superior "strength"; that is, they stand spinning and other industrial operations well, whereas any dilution of cellulose by non-cellulose substances (known to confer rigidity) is attended by weakening.

There is another theory in the field by which "lignification" is explained; according to it lignocellulose is not encrusted cellulose but a distinct compound; and the first object of the present inquiry was to ascertain whether evidence favourable to this view could be obtained.

Jute being a chemically sensitive substance requires to be much more carefully handled than does cotton, to prevent undesirable changes being established. The incipient fermentation which is set up by the treatment of "retting," and is very liable to be renewed during packing and shipment, may be cited in evidence. There is, indeed, good reason to believe that very little jute arrives in England in as good a condition as when shipped. If, however, by a simple preliminary treatment, the hydrolysable constituents, upon which the sensitiveness of the material largely depends, could be removed, the risk of further damage would be greatly lessened.

In the summer of 1894 the authorities of the Imperial Institute applied to the Indian Government for the collection and preparation of a special series of samples of jute fibre for submission to comparative examination in the Research Department. In accordance with a scheme furnished by Mr. Cross, a member of the Committee of Advice, the specimens were to be taken at different specified periods in the growth of the plant, with the view of discovering whether any distinct changes occurred, during its life-history, of a character to affect the value of the fibre. Other samples were to be cut at the usual harvest time, *viz.*, when the plant is in pod, and these were to be steeped in dilute solutions of certain chemical agents. Early steps were taken in India for the collection and preparation of the samples, which arrived in London last May. These

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being of a unique character, special invitations to inspect them were issued to the Dundee Chamber of Commerce and others interested in the subject. Mr. Collyer, the official expert referee in fibres for the Imperial Institute, also examined them, and his remarks will be found hereafter.

The samples were collected at Rahuta, a village 20 miles North of Calcutta, and were arranged in the form of three experiments, as follows:—

EXPERIMENT I.—To ascertain the quality of the fibre extracted from plants at different stages of growth.

(5 samples received.)

EXPERIMENT II.—To ascertain the result of treating jute with carbonate and sulphite of soda.

(2 divisions.)

Owing to a misinterpretation of the directions sent to India, sulphate of soda was employed instead of the sulphite; but steps have since been taken by the Indian authorities to treat samples of jute of this season's growth with sulphite of soda.

EXPERIMENT III.—To ascertain the result of treating jute with alkaline ashes.

(3 divisions.)

This first report is only concerned with Experiment I.

Preparation of samples; Experiment I.—For each of the five samples 400lb of stalks were cut and stacked to allow of fermentation and for the leaves to fall off. They were then steeped for 14 to 22 days in water, afterwards washed and the fibre extracted. The yield thus obtained averaged 24-26lb. The expert's report showed that none of these fibres were of first-class quality, and he judged that they were obtained from two different crops. The samples were chemically examined in the Research Department by a method uniform with that heretofore adopted and recorded in *The Imperial Institute Journal*, and the results were to some extent checked by Mr. Cross in his Laboratory.

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RESULTS.

JUTE.	Moisture.	Ash.	Loss by Hydrolysis. A.	Loss by Hydrolysis. B.	Loss by acid purification.	Cellulose.	Loss by mercerising.	Nitration (gain).
Experiment I.	P. c.	P. c.	P. c.	P. c.	P. c.	P. c.	P. c.	P. c.
1. Cut before flowering . .	11·55	1·1	6·2	10·5	0·8	74·	10·2	37·2
2. Cut after budding . .	8·74	1·1	8·5	11·9	0·47	76·2	10·7	32·1
3. Cut in flower . . .	10·7	1·4	9·7	11·6	0·69	74·1	12·0	32·2
4. Cut when in pod . .	10·0	1·1	8·9	12·0	2·4	74·8	8·1	33·2
5. Fully matured . . .	9·72	0·9	7·3	11·2	1·4	76·4	11·0	36·6

REMARKS

Made by Collector of Samples.	*Made by* Mr. Collyer.
EXPERIMENT I.	
1. Cut before flowering.	
A fine soft and silky fibre.	Bright, yellowish, clear; mostly good strength; best of its class.
2. Cut after budding.	
Quality inferior to above.	Bright, silky, soft, flaxy coloured. Mostly strong, fairly clear, best of the other class.
3. Cut when in flower.	
Quality still coarser.	Dull grey, specky, mostly tender mixed.
4. Cut when in pod.	
Quality like above. This is the usual time for cutting the plants in this part of the country.	Dull grey, mixed strength, rather specky.
5. Cut when the plants were fully matured.	
Inferior quality; such plants are reserved for seed only.	Bright, clear, medium strength, rather specky.

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The results of the chemical examination show no very important variation, and demonstrate that there is no sudden change in the nature of the best fibre at critical stages in its life-history. This gives considerable support to the claims, recently put forward, in favour of what may be called a *sui generis* theory of lignification, as opposed to the incrustration theory.

There *is*, however, a change which, although small, appears significant, because it is all in one direction. If the comparison of the fibres were based solely on the results of the chemical analysis, one would be led to infer that, starting from No. 1, a deterioration of the fibre occurs up to the flowering period, and that it slowly recovers when that period is passed. This inference receives decided support from Mr. Collyer's remarks on the quality of the several samples, and the useful character of the system of chemical examination adopted appears to be well supported by his report. In passing, one may with advantage note that the practical opinions on the quality of the fibre, given by distinct experts, before and after shipment, are fairly parallel; the difference in quality between samples 1 and 5 does not appear to be quite so evident to the expert in England as to the Collector in India; because, probably, the finest samples suffer most. Again, the divergence of opinion respecting No. 5 rather suggests that the expert in England is accustomed to have an altogether lower average of quality of fibre delivered to him than the expert in India is accustomed to deliver.

Since, then, it may be taken as proved that no considerable change in the best fibre occurs under normal conditions at any period of the plant's history; it remains to be ascertained whether any decided changes can be induced artifically, by modifying the vegetative habit of the plant. It seems that the crop is considered, generally over India, to be in season when the flowers appear, and to be past season when in fruit, and that the fibre, while it has more gloss, is of inferior strength, before flowering. The later it is cut, however, after that period, the coarser is the fibre. From the statement made by the Collector of these specimens (*vide ante*) that the usual time for cutting the plants in this part of the country "is when in pod" it is evident that the harvesting (which is somewhat late in Rahuta) is also late in reference to the quality of the product. In connection with

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this fact, it will be noted that the expert classed the earliest specimens as distinctly superior both in appearance and strength to the samples gathered at the customary period.

These considerations point to the desirability of trying one further experiment, *viz.*, to determine the possible effect of a suppression, as far as practicable, of the flowering period upon the quality of the fibre. This might be done by selecting plants in various parts of a crop, giving them some distinctive marking, and systematically nipping off, as far as they are accessible, the flower-buds as they appear; the fibre from plants thus treated to be compared with that of the rest of the crop. It is probable that the fibre would be considerably improved in strength, owing to the assimilation by it of much of the nutriment absorbed by the flower-buds under normal conditions; it may also be that the fibre of plants thus treated will sustain in a minor degree that degeneration in quality which appears to mark the later stages in the normal life of the plant.

It will be understood that the primary object of suggesting experiments of this nature is to trace the chemical history of the fibre, and the circumstances which influence its quality, in connection with the life-history of the plant. The thorough determination of these, by sufficient confirmatory repetitions of experiments, can scarcely fail to lead to modifications in cultivation having a substantial commercial bearing upon the jute industry.

The great importance of gathering seed only from the best grown and strongest plants need perhaps scarcely be insisted on. Although it may be quite impossible to enforce this procedure generally, there should probably not be the same difficulty to secure it at Rahuta, at all events on an experimental scale.

The next report will deal with the samples of fibre, which have been submitted to chemical treatment before shipment.

Further action taken in India.

In fulfilment of the promise made in F. S. S. No. 9 to I. I., dated the 13th July 1895, steps were taken to have the experiment No. 2 repeated and to treat the jute with sulphite of soda as suggested by F. S. S. letter No. 47 from the I. I., dated the 28th May 1895. At the same time the co-operation of the Director, Land Records and Agriculture, Bengal, was solicited in the matter of continuing the

EXPERIMENT No. II.

Action taken to procure its repetition

experiments with two species of jute, *viz.*, **Corchorus olitorius** and **C. capsularis**, on the following lines:—

SPECIMENS REQUIRED.

(1) Fibre obtained from 20 plants of each kind of the jute plant cut on the 15th of August.

(2) A piece of the stem cut one foot from the ground preserved in spirit.

(3) Both fibre and stem (as in 1 and 2) from 20 plants cut from the same field (as in 1 and 2) every tenth day from the 15th of August until the plant begins to dry up.

It was added that the object of these experiments was to ascertain the difference (if any) in the value of the fibre extracted from the plant during different stages of growth.

The following note and covering letter on the methods of steeping jute adopted in Bengal by Dr. J. W. Leather, Agricultural Chemist to the Government of India, may be given here.

Bengal. Methods of steeping jute described by Dr. Leather.

From the Agricultural Chemist to the Government of India, to the Director of Land Records and Agriculture, Bengal,—No. 183, dated the 17th September 1895.

With reference to my recent tour in the Jute Districts of Bengal, I have now the honour to submit to you a copy of the Notes which I took whilst at the several places I visited.

2. The object of my visit is defined in paragraph 4 of your letter No. 2932 A., dated 26th December 1894, to the Secretary to the Government of Bengal, Revenue and Agricultural Department. At the time of my visit the steeping process was in operation and I had a good opportunity of seeing it under the various conditions which exist. But as regards any nuisance which arises therefrom, I found practically none *at the time of my visit*. So far as I could learn, the odours which arise from the decay of the refuse vegetable material occur later in the year, when the land is drying up.

This is a subject which has occupied the attention of the sanitary authorities for, I believe, many years, but so far as I could learn very little definite action has been taken. At one place only, namely, Serajganj, did I hear that an attempt had been made to surmount the nuisance. There, I understood, the sanitary authority had attempted

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to persuade the cultivators to steep (and strip) the plant away from the village site.

Under the conditions which at present obtain for the preparation of the fibre, this is probably the most which can be done. The circumstances do not allow of much interference. We have the plant in one place growing in 6 feet of water, as, for instance, at Narainganj; at another it is grown on almost dry land. For the steeping moderately deep water is requisite, and bearing in mind the immense weight of the crop, all of which has to be carried by hand, it seems to me useless to expect that the cultivator can afford to carry the crop any great distance. He is almost compelled to steep it in the nearest water available.

I am doubtful if the *steeping* is the cause of the odours,—it occurs to me that it is more probably the refuse material from the *stripping* process which does this.

But here again the circumstance of the weight of plant almost dictates that the cultivator cannot afford to carry this steeped plant to some (sanitarily) convenient spot for the purpose of stripping. It is naturally much cheaper for him to strip it where it is steeped.

At Serajganj and at Jalpaiguri the steeping and stripping appeared to be done very commonly away from the village site, or at least not entirely at that spot.

At Narainganj it appeared to be *mostly* done at the village site. But the circumstances were different. At Narainganj there was so much water that the people had to go everywhere in boats. The plant grew several feet in water, and although steeped where it was cut, the plant, when ready for stripping, was readily carried in a boat to the dry land. Some was stripped by the operator sitting on a raft of plantain stems, but the major part of the operation was performed at the only dry land available, *i.e.*, the village; and I should imagine that it would be practically impossible to alter the state of things which prevail. It is a case where the weight of crop and the amount of water appear to be controlling factors.

Separating the fibre.

3. I have in my Notes described in some detail the method of beating the fibre from the stem which obtains in many parts. This process is not described in Watt's Dictionary and only very imperfectly in Mr. Hem Chunder Kerr's Report* on the Jute Trade of Bengal. It is essentially different from the stripping process. I enquired of

* Pages 33 and 50.

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the merchants whom I met whether there was any difference noticeable between the quality of the fibre which is produced at Narainganj and at Serajganj. At the former place I only saw the *stripping* process, whilst at the latter all, or nearly all, the fibre is *beaten* out; and since it is subjected to very severe treatment during the latter process I thought a difference might be known to exist in the quality of the resulting fibre. But, so far as I could learn, no such difference is recognised.

4. As regards the time required to separate a certain amount of fibre by the two methods, I did not make any very exact determinations, but, as I have explained in my Notes, the conclusion to which I came is that there is no great difference.

5. I may in conclusion refer to another question which, I understand, has been submitted to you by the Reporter on Economic Products, namely, the difference in quality of the fibre according to the age of the plant. You are at present making some direct experiments on the subject. The point which occurred to me is this. At Narainganj I found the plant in a much more advanced stage of growth than at Serajganj. At the former it had all passed the flowering stage and much was in seed, whilst at Serajganj much of the plant had not reached the flowering stage and none that I saw was in seed. But the merchants assured me at Serajganj that the jute is generally considered *later* at Narainganj (by a fortnight) than at Serajganj, and if this year is at all a normal one with the crop it follows that the plant at Serajganj is generally harvested at *an earlier period of its growth* than at Narainganj. If, therefore, there is any material difference in the quality of the fibre at different periods of growth, it should be noticeable by a comparison between that from Narainganj and that from Serajganj.

6. I beg to return under separate cover the copy of Mr. Hem Chunder Kerr's Report which you kindly lent me.

Notes on Methods of Steeping Jute.

Narainganj, 18th August 1895.—Plant cut from time of flowering until when fruit forms. Sometimes growing 3-6 feet in water, sometimes crop is almost on dry land.

In the former case, boys dive down with a sickle and cut it off and build up the retting heap on the spot. If growing on dry

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BENGAL. METHOD OF STEEPING JUTE.

Described by Dr. Leather.

land it is cut off and carried to water for retting. The cost of cutting comes to much the same in either case, for in the former the cutting takes more time, whilst in the latter extra labour is spent in carrying the plant to water.

Boys take about 10-12 seconds to cut 3 or 4 stems off in 4 or 5 feet of water.

The stalks of jute are several feet in height. They are covered with leaves and grass to make them sink. The time given to retting varies apparently with the age of the plant. One man said if the plant is cut in flower, the fibre would be ready for stripping in 13-14 days. Another man, whose jute was cut after flowering, had steeped for 20 days and it was then hardly ready. The hamlets generally are small and occupy little spaces of land which are just above the water. The cattle stand under sheds while the land is under water and get no exercise.

The stripping is carried on at the village site very largely, although some is also stripped in deep water. The man takes one or two (not more) stems, takes off all adventitious roots by running the closed hand down stem, then gets hold of fibre at "root" end of both stems at once, and by passing the fingers along the stem, it is separated from the stem.

It is then washed in the water to get most of the green bark away and hung up to dry. Sometimes it receives a second washing—apparently when very little or very dirty water occurs at village site.

The leaves are not stripped off, but appear to rot under the water during the process of retting almost entirely. The people say that stagnant water is the best, and that retting takes place more quickly in it. As a matter of fact they have to use whatever water is nearest, for it would not pay to carry the whole plant far, and also, over a very large area, the land is simply covered by *running* water.

At the village site, where stripping takes place, a large amount of the refuse "adventitious roots" collects, and this mixed with urine, etc., from cattle-sheds forms a very filthy mass and causes some odour. But there was no odour so very objectionable. In any case it is doubtful if this state of things could be remedied. Much of the stripping is done by the women and children and these probably could not work in deep water. But the odours were nothing to

BENGAL. METHODS OF STEEPING JUTE.

Described by Dr. Leather.

Time occupied in stripping.

what I had expected. Of course they may be worse when the land is drying up.

I did not time this operation, but I believe that not more than 5-7 seconds are occupied in it, which gives a rate of some 8-12 stems (if done singly) per minute, or 16-24 if two are done at once, which latter is a very common practice.

Serajganj, 21st August 1895.—The jute appears to be distinctly younger here, for much had not reached the flowering stage, whilst the rest was in flower, but none that I met with was in seed. Some is pulled up, but most is cut. What I saw was mostly not more than 1 foot in water and much not that. It is then treated according to how much water happens to be on the land.

Cutting.

If the water is deep all round they stack it for retting at once. If there is a foot or so of water they put it (in bundles) upright until a stack, say 6 feet in diameter, is formed.

If land is practically dry, the plant (in bundles) is laid out on the land.

In either of the latter cases the people let it remain thus for a day or two and then knock off the leaves, which are readily detached, and then put in water for retting.

Retting.

I was told that some jute is only retted for two days or so, but the different ryots I met with retted for 10-20 days.

The plant which I saw had not so much adventitious roct as that which I saw at Naraingani.

Separation of fibre.

Although one ryot said that the fibre is, in another part of the district, stripped as at Naraingani, all that I saw was separated by *beating* and not stripped at all. The process of beating is curious. A bundle of about 20 stems is taken in the left hand and most of the adventitious root removed with the right hand. Then the man takes a small wooden "beater" about a foot long with 6" handle, and flat sides, and after striking the bottom ends of stems until they are all level, he beats the lower portion of the bundle, so as to loosen the fibre, turning it in the left hand at the same time. He then breaks the bundle at about the centre, first one way, then the other. Then clasping the bundle, still in left hand, just above the point of fracture, he strikes at the stems, with the beater, just below the fracture, in a downward sort of way, and this knocks the wood

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stem outwards, so that after a few sharp strokes, and a little violent agitation in the water, up and down, he can take hold of the stems and pull them out from the fibre, leaving it almost free from w ood.

He then takes hold of this part of the fibre, coils it round the right hand up to the point where the upper half is still entire, and agitates this, the upper part, in the water, when the fibre comes right away from its woody stem. The fibre still contains some pieces of broken wood, most of which is picked out; and the bundle of fibre is simply washed in water, then tied up in a "hank" and put on the boat or heap. It, however, still contains some bits of wood. The time occupied depends doubtless on the perfection of the retting process and on the skill of the operator. I timed one man who seemed skilled and he took 2 minutes to do a bundle of some 20 stems; but another boy using the same material, did not take such large bundles and worked much slower. I also saw another man who required 3¼-3½ minutes to beat out a bundle, but he said the fibre would not leave the stem properly, and it appeared to me that this was the case.

Another man said that if the jute is properly retted, he could knock out 1 maund of fibre a day, but if not properly retted he would only get through 10 seers.

Although at Serajganj they separate the fibre of some 20-30 stems at once, I doubt if more work is done (if as much) as at Narainganj, where the stems are stripped singly or in pairs. Moreover, so far as I could see, the women and children do not strip at Serajganj, whereas they all help at Narainganj.

Jalpaiguri.—Here the methods of steeping jute and of stripping off the fibre are similar to those in vogue at Serajganj. The jute plant is, however, principally the *red* stem variety, only a minor portion, so far as I was able to observe, belonging to the light green stemmed variety. There was not at the time of my visit anything like so much water as at Serajganj or at Narainganj, and practically all the crop was grown on "dry" land, *i.e.*, not *in* water.

Here I found that the stripping and steeping of the plant had been temporarily suspended, all the people being busy with transplanting rice, much of which seems to go on to land which had already borne a jute crop.

BENGAL. EXPERIMENTS WITH JUTE.

On the 5th November 1895 the despatch of specimens of Jute to the I. I. was advised as under:—

Despatch of further samples to I. I.

From George Watt, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Indian Museum, Calcutta, to* Sir F. A. Abel, Bart., K.C.B., *Secretary and Director, Imperial Institute, London,—No. 1437—69, dated the 5th November 1895.*

In connection with correspondence ending with your letter No. 486—64 (Flying Seal Series No. 55), dated the 17th September last, I have the honour to advise the despatch of the following specimens of Jute prepared at Rahuta, under the direction of this office, from plants obtained from the same crop and one and the same field:—

Conf. p. 9.

(1) Jute, steeped in Sulphite of Soda for ten minutes, just after extraction of the fibre.

(2) Do., steeped in Sulphite of Soda for thirty minutes.

(3) Do., not treated with any chemical.

(4) Do., obtained from ten plants, cut on the 16th July 1895, and fibre extracted on the 29th July.

(5) Do., cut on the 26th July and fibre extracted on the 10th August.

(6) Do., cut on the 5th August and fibre extracted on the 19th August.

(7) Do., cut on the 15th August and fibre extracted on the 28th August.

(8) Do. (flowering stage), cut on the 25th August and fibre extracted on the 8th September.

(9) Do., cut on the 4th September and fibre extracted on the 18th September.

(10) Do., cut on the 14th September and fibre extracted on the 29th September.

(11) Do., cut on the 24th September and fibre extracted on the 11th October.

2. Specimens Nos. 4 to 11 have not been treated with chemicals, as they are intended to illustrate the quality of the fibre obtained from stems cut every tenth day from the time they were about five feet in height. Similar specimens are expected from East Bengal prepared under the supervision of the Department of Land Records

BENGAL. EXPERIMENTS WITH JUTE.

and Agriculture, Bengal, and from the District of Burdwan* prepared by a private gentleman, named Babu Jogendra Nath Mitra.

Despatch of further samples to I. I.

3. With reference to the request made in paragraph 2 of your letter quoted above for a sample of jute treated with carbonate of soda, I regret my inability to comply as the jute season is now over.

4. With regard to the suggestion for trying the effect of nipping off the flower-buds as they appear from plants in different portions of the crop, I beg to state that it is now too late to make the experiment this year. Efforts will, however, be made next year to comply with the request, but I am afraid great difficulty will be experienced in carrying out your recommendation owing to the facts :—(1) that the plants at the flowering stage are often found to be growing in fields many feet under water ; (2) that the crop is so dense that it would be found difficult to walk through the fields in order to nip off the buds.

5. I may, moreover, be excused if I express a doubt as to the possibility of effecting any changes in the system of jute cultivation or separation of fibre. I do so on account of the physical conditions of the narrow tract of country in which the cultivation of jute can be undertaken. At present, the crop is confined, as you doubtless are aware, to the inundated tracts of Eastern Bengal and Lower Assam. It not only requires to grow in water but under a tropical atmosphere that exists in a state of complete saturation during the growing period of the plant. Jute has been tried both in Bombay and Madras and found a failure. With perhaps the exception of some districts of Burma there are no other parts of India where jute is or can be grown. It may be said, therefore, to be not only confined within narrow limits geographically but meteorologically. Unless some simple chemical method of improving the fibre (in the condition in which it comes to the market) can be designed, I am afraid no changes in the cultivation or method of separation are practicable, for the simple reason that the physical conditions of the region in which jute is produced will admit of no changes.

6. I am desired to acknowledge receipt of the preliminary report furnished by Mr. Cross, and to say that it is deemed of sufficient interest to be published (as a first instalment) in *The Agricultural Ledger.* Should, however, further contributions from Mr. Cross reach India within the next six weeks or so, they would be in time for incorporation ; otherwise the completion of his report will be reserved for another issue of the Ledger.

CORCHORUS. **Methods of Harvesting Jute**

IMPERIAL INSTITUTE.

This communication was acknowledged by the following letter :—

From SIR F. A. ABEL, BART., K.C.B., *Secretary and Director, Imperial Institute, London, to* GEORGE WATT, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Indian Museum, Calcutta,—No. 226, dated the 5th December 1895.*

I have to acknowledge, with many thanks, the receipt of yours of the 5th ultimo (Flying Seal Series No. 27), in which you advise me of the despatch of a series of specimens of the jute, prepared at Rahuta under your direction.

I only desired to have a sample of jute treated with carbonate of soda, because of the advisability of comparing one and the same sample of fibre treated in that way and by means of sulphite of soda.

With respect to paragraphs 4 and 5 of your letter, I may state that I thought it advisable to submit the suggestion of Mr. Cross as to trying the effect of nipping off the flower-buds from the plants, although I apprehended that great difficulties would be met in carrying it out, and had no doubt that the experiment, though interesting, could lead to no practical result. I have communicated to Mr. Cross the statements contained in the above paragraphs of your letter, but I shall be glad to be informed, in your next communication on this subject, whether the circumstances pointed out by you, which preclude the possibility of effecting any change in the system of jute cultivation, apply equally to any change which might suggest itself in the system of separating the fibre from the plant when collected.

Should I hear further from Mr. Cross on this subject, I will communicate at once with you. Meantime, a further sample and report upon these specimens of prepared jute will be forwarded as soon as those now under weigh have been submitted to examination.

The letter which succeeds is given here with special reference to the last and penultimate paragraphs regarding two fibre plants of the jute type :—

From SIR F. A. ABEL, BART., K.C.B., *Secretary and Director, Imperial Institute, London, to* GEORGE WATT, Esq., M B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Indian Museum, Calcutta,—No. 219—69, dated the 20th February 1896.*

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With reference to my letter of the 28th May last, in which I sent you the Reports of practical experts on the market value of the

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Comparative examination of Sunn Hemp.

sample of Sunn Hemp **(Crotalaria juncea)** from Burma received from you a short time since, I have now the pleasure to send you the results of the submission of this sample to the comparative method of examination adopted for fibres in the Research Department, together with those furnished by a specimen of the same species of fibre grown in Calcutta, which has been taken from the collection of fibres in the Indian Section.

	Moisture.	Ash.	Loss by (*a*) Hydrolysis.	Loss by (*b*) Hydrolysis.	Loss by Mercerising.	Loss by Acid purification.	Gain by Nitration.	Cellulose.	Length of ultimate fibre.
LEGUMINOSÆ.	P. c.	P. c.	P. c.	P. c.	P. c.	P. c.	P. c	P. c.	M. M.
Crotalaria juncea (Burma) . .	9·8	3·1	9·2	15·8	8 8	3·7	35	87·4 87·5	5- -8
Crotalaria juncea (Calcutta) . .	9·4	·5	10·5	·14	9·1	1·6	?	90·6 91·0	5- -5·5

2. It will be seen from the results given that this examination confirms the opinion arrived at by the practical experts in regard to the good quality of this fibre.

An examination has also been made of two descriptions of fibre from India, which were among those specially referred to by Mr. Daniel Morris, C.M.G., of the Royal Gardens, Kew, in a course of lectures which he has recently delivered on fibres at the Society of Arts. The following are the results obtained :—

	Moisture.	Ash.	Loss by (*a*) Hydrolysis.	Loss by (*b*) Hydrolysis.	Loss by Mercerising.	Loss by Acid purification.	Gain by Nitration.	Cellulose.	Length of ultimate fibre.
MALVACEÆ.	P. c.	P. c.	P. c.	P. c.	P. c	P. c.	P. c.	P. c.	M. M.
Hibiscus cannabinus (Saharanpur) . .	10·8	1·	12·2	19·1	18·3	2·7	40·	74·9	3- -4
Urena lobata (Manbhoom) . . .	9·9	2·4	12·2	16·3	15·7	3·0	25·8	73·5	2·2- -5

Fibre of Hibiscus cannabinus superior to jute.

The **Hibiscus cannabinus,** which has, I believe, been proposed as a substitute for jute in some districts of India where the latter is not cultivated, is shown to be superior to jute of average quality. The measurements of length of fibre have been carefully made, and they

IMPERIAL INSTITUTE.

Comparative examination of Urena lobata.

agree with those obtained by Messrs. Cross and Bevan in the examination of a sample of fibre from the Colonial and Indian Exhibition.

The **Urena lobata** is also a fibre of the jute type possessing very similar qualities to jute. The staple of the fibre is short, and the percentage of cellulose which it was found to contain is somewhat lower than that observed by Messrs. Cross and Bevan in their published analysis of a sample of the same description of fibre.

In amplification of F. S. S. letter No. 27, dated the 5th November 1895, a further letter was addressed to Sir F. Abel the material portions of which, paragraphs 2 and 3, are reproduced below:—

From George Watt, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Calcutta, to* Sir F. A. Abel, Bart., K.C.B., *Secretary and Director, Imperial Institute, London,—No. 529—69 F.S., dated the 11th March 1896.*

* * * * * *

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2. Your letter No. 64 acknowledges receipt of the samples recapitulated above and asks to be informed whether my remarks as to "any change in the system of jute cultivation apply equally to any change which might suggest itself in the system of separating the fibre from the plant when collected." I would point out that my previous letter stated that that was so, but it may perhaps be desirable to explain my views of the case more fully. Jute is pre-eminently a crop of tropical swamps, luxuriating as it does when half submerged in 3 to 6 or 8 feet of water. It is grown during the rainy season when the atmosphere is such that nothing can be kept more than a few hours without undergoing rapid putrification. The stems could not therefore be preserved for the time necessary to be carried from the fields to a factory or machine. The people of such regions and particularly at that season of the year, are not characterised by possessing a superabundance of energy or enterprise. The fibre is sold for so very little that it could not afford to be burdened with any extra charges over that of the cultivator's labour in retting the stems and beating the fibre in pools of the water that are everywhere at hand. If extra charges have to be imposed, they must be borne by the buyers—the merchants or mill-owners. The fibre is required for a specific purpose which it fulfils admirably. No one wants it

JUTE CULTIVATION IN BENGAL.

Remarks by the Reporter.

improved. To make the fibre stronger and more durable would practically ruin much of the present demand. If a better fibre be required for a market a little higher than that of Jute, why not adopt Sida or many other better fibres than Jute that could be extensively grown where jute cultivation is impossible ?

These and such like considerations are the grounds on which I base my opinion that in neither the methods of cultivation nor process of separation of the fibre is there much room for improvement.

3. The chief improvement the jute mills would welcome would be a larger supply of a more uniform quality of fibre. And there are among others at least two directions on which the latter consideration might be realized. First, improvement of stock by selection. There are, for example, two species of **Corchorus**, the fibres of which are known as jute, and within each of these species numerous races. If the chemist were to show that the want of uniformity proceeds from the various forms of the plant yielding fibres of widely different properties, which from want of selection of stock become mixed of necessity, then influence might be brought to bear on the subject of the seed used by the cultivators. In the second place, if the chemist shows that there is a definite age in the plant at which the fibre is ripe and beyond which it degenerates, influence might be brought to bear on the cultivators to reap their crop at the approved period. But there would be great difficulty no doubt in securing punctual reaping, as the crop has often to wait the convenience of the limited labour supply at the cultivator's disposal. But the principle I have advocated that improvements that could be effected without materially increasing the cost of production or the labour of the cultivators would be a measure of practical importance, but beyond that they are not likely, for the next century at least, to become of value to the people of this country, however interesting they might be.

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Sir F. Abel replied as follows :—

From SIR F. A. ABEL, BART., K.C.B., *Secretary and Director, Imperial Institute, London, to* GEORGE WATT, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Calcutta,—No. 301—70, dated the 15th April 1896.*

I have the honour to acknowledge the receipt of your letter of the 11th March last, which relates to previous correspondence on the *Conf., p. 22.*

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subject of Jute cultivation and preparation, and to experiments bearing thereon which have been suggested by Mr. Cross. It usefully amplifies the information previously furnished by you in support of the doubt expressed in your letter of November 5th, 1895, as to the possibility of effecting any changes in the system of Jute cultivation, or of separation of the fibre. The reasons given in the letter last referred to, for the doubts entertained by you on the subject (paragraph 5), appeared to me to apply exclusively, or nearly so, to the physical conditions necessarily attending the *cultivation* of jute, especially as you referred to the possibility of the discovery of some simple chemical method of improving the fibre (in the condition in which it comes to the market). Hence the repetition of the enquiry "whether you considered the circumstances pointed out by you, which preclude the possibility of effecting any change in the system of jute *cultivation*, apply to any change which might suggest itself in the system of *separating the fibre*."

Reply of Sir F. Abel.

Your letter (paragraph 2) of the 11th March now makes it clear that the conditions surrounding the cultivation of Jute, together with the very perishable nature of the plant, and the very low price at which the fibre is only saleable, practically preclude the introduction of any improvements upon the method of operating in use for *separating* the fibre.

You now state, moreover, that no demand exists for any improvement in the quality of the fibre, which fulfils admirably the specific purpose for which it is required; but this statement is qualified by your observation (paragraph 3) that the chief improvement which Jute Mills *would welcome* would be a larger supply of fibre of more uniform quality. In your letter of March 11th you point out two directions wherein it may perhaps be possible to indicate measures the adoption of which may tend to secure greater uniformity in the character and quality of fibre sent into the market.

The results of experiments have already been reported upon, and others are now in progress of completion, which serve, at any rate, to indicate whether practical results are at all likely to be achieved in one of those two directions; namely, whether there appears to be a particular age of the plant at which the fibre attains its highest quality, and beyond which it degenerates. The results of chemical experiments in the Research Department (reported upon to you in

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Reply of Sir F. Abel.

September last) with samples of fibre extracted from specimens of the plant at five different periods of its age, demonstrated that there was no very marked change in the character of the fibre between any two definite periods in the life-history of the plant, but that a decided superiority was exhibited by the fibres extracted from the plant, cut when the buds *had approached* the flowering stage, over the fibre representing the plant both at an earlier stage (when budding had taken place), and also at later stages in its life; a superiority which was corroborated by the opinions of a practical expert here, and of the collector of the samples in India. This observation, of course, needs corroboration by the further examination of more than one series of samples. The series of specimens of fibre extracted from samples collected at intervals of ten days from the flowering stage, the despatch of which was advised in your letter of the 5th November 1895 (F. S. S. No. 27), bear upon this subject, and the results of their examination in the Research Department will shortly be reported.

With respect to the other direction, in which you suggest that uniformity of quality of fibre might perhaps be advanced, namely, the improvement, by selection, of the stock from which it is cultivated:—it certainly appears advisable that a comparative chemical examination should be instituted of fibres furnished, respectively, by plants of the two species of **Corchorus (olitorius** and **capsularis)** which are cultivated for jute, and also by well-marked specimens of such distinct races of those species as are recognisable among plants which are cultivated under the general designation of jute-plants.

There is another, and probably important, direction, in which variations of uniformity in character and quality of fibre, furnished even by one and the same species, or race, may be sought, namely, in the character of the *soil* in which the plants may be cultivated, and which, according to statements in the article on jute (page 549, Volume II) in the Dictionary of Economic Products, appears to vary considerably in character. If the subject of a possible improvement of jute-cultivation were to be exhaustively inquired into, this element among variable conditions would demand careful attention.

It would, however, probably be advisable in the first instance to limit an extension of the experimental enquiry to the chemical examination and export-inspection of fibres furnished by plants of

BENGAL.

Results of further experiments.

the two different species of **Corchorus**, and by distinct and most frequently occurring races of those species, which have been grown under approximately similar conditions as regards soil, climate, etc.

If it is decided to pursue the investigation in this direction, arrangements will be made in the Research Department for the expeditious examination of any further series of samples of fibres which may be collected.

In the meantime a communication was received from the Director, Land Records and Agriculture, Bengal, No. 367 A., dated 12th March 1896, forwarding together with specimens the following two statements showing results obtained from the experiments with jute at the Burdwan and Sibpur Experimental Farms :—

STATEMENT I.

Extraction of Jute Fibre.

Experiment made at the Burdwan Farm by Babu Debi Persad Chowdhury, *Overseer, Burdwan Farm, under the instructions of* Mr. N. N. Banerjee, *Assistant Director of Land Records and Agriculture, Bengal.*

No. of speci-mens.	Date of cutting.	Date of immer-sion in water.	Number of days kept in water.	Date of extraction of fibre.	Kind of water in which jute was immersed.	Number of plants.	Weight of plants at date of cutting.		Weight of plants at date of immersion.		Weight of fibre.	
1	2	3	4	5	6	7	8		9		10	
							lb.	oz.	lb.	oz.	lb.	oz.
1	1st September 1895.	5th September .	17	22nd September	Canal water .	20	9	14	9	4	0	8
2	Ditto .	Ditto .	17	Ditto .	Jheel " .	20	10	8	10	0	0	8
3	11th September 1895.	16th September	24	10th October	Canal " .	20	9	12	9	5	0	10
4	Ditto .	Ditto .	24	Ditto .	Jheel " .	20	10	8	10	1	0	11
5	21st September 1895.	27th September	33	30th October .	Canal " .	20	10	0	9	12	0	10
6	Ditto .	Ditto .	26	23rd ditto. .	Jheel " .	20	9	14	9	10	0	10
7	1st October .	8th October .	24	1st November .	Canal " .	20	9	14	9	10	0	10½
8	Ditto .	Ditto .	24	Ditto .	Jheel " .	20	9	8	9	3	0	10
9	11th October .	18th October .	33	20th November	Canal " .	20	10	8	10	2	0	13
10	Ditto .	Ditto .	33	Ditto .	Jheel " .	20	9	8	9	3	0	10½
11	21st October .	27th October .	39	6th December .	Canal " .	20	9	14	9	10	0	12½
12	Ditto .	Ditto .	39	Ditto .	Jheel " .	20	9	8	9	4	0	12

CORCHORUS. **Methods of Harvesting Jute**

BENGAL.

Experiments with Jute at Sibpur.

STATEMENT II.

EXTRACTION OF JUTE FIBRE.

Experiments made at the Sibpur Farm by the Overseer in charge of the Farm under the directions of Mr. N. N. Banerjee, *Assistant Director of Land Records and Agriculture, Bengal.*

No. of specimens.	Date of cutting.	Date of immersion in water.	Number of days kept in water.	Date of extraction of fibre.	Kind of water.	Number of plants.	Weight of plants.		Weight of jute.
1	2	3	4	5	6	7	8		9
							Seers. *lbs.*	Chattaks. *oz.*	Tollas. *oz.*
1(*a*)	25th August 1895 .	25th August .	15	9th September .	Tank . .	20	2 *6*	15 *6·8*	11 *4·52*
1(*b*)	Ditto .	Ditto .	11	5th ditto .	Jheel . .	20	3 *7*	11 *9·3*	11 *4·52*
2(*a*)	4th September 1895.	4th September .	21	24th ditto .	Tank . .	20	3 *7*	12 *11·4*	13 *5·34*
2(*b*)	Ditto .	Ditto .	9	13th ditto .	Jheel . .	20	3 *6*	5 *13·0*	14 *5·76*
3(*a*)	13th December .	13th December .	21	4th October .	Tank . .	20	3 *7*	11 *9·3*	13 *5·34*
3(*b*)	Ditto .	Ditto .	9	22nd September .	Jheel . .	20	4 *8*	2 *7·7*	15¾ *6·48*
4(*a*)	22nd December .	22nd December .	36	28th October .	Tank . .	20	3 *6*	2 *6·8*	10¼ *4·21*
4(*b*)	Ditto .	Ditto .	12	4th ditto .	Jheel . .	20	3 *7*	7 *1·1*	13 *5·34*
5(*a*)	3rd October .	3rd October .	27	30th ditto .	Tank . .	20	3 *6*	3 *8·9*	13½ *5·55*
5(*b*)	Ditto .	Ditto .	17	20th ditto .	Jheel . .	20	3 *8*	15 *1·6*	16½ *6·78*

NOTE.—1 Tolla = $\frac{72}{175}$ oz. 1 Chattak = $2\frac{2}{35}$ oz. 1 Seer = $2\frac{2}{35}$ lb.

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BENGAL.

Experiments with Jute in the Jalpaiguri district.

This was succeeded by the Director's letter No. 824 A., dated the 23rd May 1896, forwarding specimens and a statement showing results obtained from the experiments with jute conducted in the Jalpaiguri District under the supervision of the Department of Land Records and Agriculture, Bengal.

STATEMENT No. 1.

EXTRACTION OF JUTE FIBRE.

Experiments made in the District of Jalpaiguri by Babu Hara Kumar Guha, *Overseer, Agricultural Department, under the instructions of* Mr. N. N. Banerjee, *Assistant Director of Land Records and Agriculture, Bengal.*

No. of specimens.	Date of cutting.	Date of immersion in water.	Number of days kept in water.	Date of extraction of fibre.	Kind of water in which jute was immersed.	Number of plants.	Weight of fibre.	Remarks.
1	2	3	4	5	6	7	8	9
1	2nd September 1895.	2nd September 1895.	14	16th September 1895.	Tank water .	20	5¼ oz.	
2	Ditto .	Ditto .	16	18th September 1895.	Running water .	20	3¼ oz.	
3	12th September 1895.	12th September 1895.	13	25th September 1895.	Tank water .	20	5¼ oz.	
4	Ditto .	Ditto .	24	6th October 1895.	Running water .	20	6¾ oz.	
5	...	...	...	...		...	...	Specimens of stems cut on the 2nd September 1895.
6	...	...	...	...	...	...	...	Specimens of stems cut on the 12th September 1895.

IMPERIAL INSTITUTE.

Experiments on Indian Jute. Second Report.

A second Report was received from th I. I. with the following letter :—

From SIR F. A. ABEL, BART., K.C.B., *Secretary and Director, Imperial Institute, London, to* GEORGE WATT, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Calcutta,—No. 427—70, dated the 24th April 1896.*

Referring to my letter of the 17th September last, in which I forwarded you the first report on the results of experiments with special samples of jute fibre supplied from your Department, and my letter to you of the 15th instant on the same subject, I have now the pleasure to forward you a second report which deals with the results of examination of the samples of fibre treated with solutions of different salts.

In my opinion these results sufficiently demonstrate that no practical advantage would be likely to be secured by treatment of the fibre with alkaline liquids, or with weak oxidising solutions in the direction suggested by Mr. Cross, *viz.*, that of protecting the fibre against fermentative and other changes to which it is liable during transport.

SOME EXPERIMENTS ON INDIAN JUTE.

SECOND REPORT.

Conf., p. 10.

The Report submitted on the 17th September in Flying Seal letter (No. 55) of that date, dealt with the relations between the age of the jute plant, and the quality of the fibre yielded by it. The present report gives the results of experiments made with a view to determine whether the treatment of the raw fibre, soon after its extraction from the plant, with solutions of one or other of certain chemical salts, would be likely to protect the fibre against fermentative and hydrolytic changes to which it is liable during transport in a closely packed condition.

The samples received from the Agriculture and Revenue Department were described as having been collected from one field at about the usual time for harvesting, *i.e.*, when the plant is in the pod stage. Quantities of about 40lb of the freshly-stripped wet fibre had been steeped in the solutions, afterwards washed in water, and dried. The average amount of dry jute so obtained was 14 to 15lb.

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The following are short details of the samples :—

Experiment II, *No* *5226*.—40lb of wet jute fibre, simply washed in water and dried, for purposes of comparison.

" " " *5227*.—40lb of fibre were put in a 2 per cent. solution of sodium carbonate, which was then gradually raised to the boiling point, and then allowed to cool, when the fibre was wrung out and dried. The fibre assumed a red colour.

" " " *6693*.—40lb of jute unsteeped for comparison with the following :—

" " " *6690*.—40lb were steeped for 10 minutes in a cold 2 per cent. solution of sodium sulphite, then removed, washed, and dried.

" " " *6689*.—40lb were steeped for 30 minutes in a cold 2 per cent. solution of sodium sulphite, then washed and dried.

Experiment III, *No*. *5232*.—40lb were placed in 50lb of water containing $3\frac{1}{8}$lb of plantain ash, which was then raised to boiling point; when it had cooled the fibre was removed, washed and dried.

" " " *5234*.—40lb were steeped in solution of tamarind ash (of the same strength as above), and treated in the same way as the previous sample.

" " " *5236*.—40lb were steeped in a solution of *babul* ash (the strength of solution and the treatment being as in the preceding samples).

CORCHORUS. **Methods of Harvesting Jute**

IMPERIAL INSTITUTE.

Experiments on Indian Jute. Second Report.

The following is a table of chemical results with the remarks of an expert, who has inspected some of the samples :—

	Moisture.	Ash.	Loss by Hydrolysis (A).	Loss by Hydrolysis (B).	Loss by Mercerising.	Loss by Acid purification.	Gain by Nitration.	Cellulose.	Remarks.
	P. c.	P. c.	P. c.	P. c.	P. c.	P. c.	P. c.	P. c.	
Experiment II—									
No. 5226 Unsteeped jute . .	9·5	1·4	9·7	11·6	...	...	41·7	77·5	A tender sample.
No. 5227 Steeped in sodium carbonate .	10·2	2·5	9·7	14·6	...	...	44·8	77·5	Mixed strength, dark colour.
No. 6693 Unsteeped jute . .	11·1	1·0	8·5	8·7	8·8	0·9	45·0	78·2	
No. 6690 Steeped for 10 minutes in sulphite of soda .	11·0	1·7	7·9	12·8	11·0	1·1	40·0	75·4	
No. 6689 Steeped for 30 minutes in sulphite of soda .	9·3	1·8	8·0	11·3	11·8	2·7	43·0	77·1	
Experiment III—									
No. 5232 Treated with plantain ash	9·3	1·6	8·8	11·8	...	...	40·0	79·0	Light brown, rather specky, med. strength.
No. 5234 Treated with tamarind ash . .	11·8	1·6	7·0	9·9	...	...	40·0	78·7	Good strength.
No. 5236 Treated with *babul* ash .	10·8	·86	6·	9·6	...	...	46·2	78·7	Specky, fair strength.

The samples of jute used in the experiments with sulphite of soda was of high quality, as shown by the results obtained with the untreated sample (No. 6693). The hydrolysis and mercerising figures are remarkably low and constant; the nitration number is good and the percentage of cellulose is well above the average. Judged solely by chemical results, this is the best sample of jute that has been examined in the Research Department. The colour of the fibre was perhaps a trifle dark, but the gloss was good, and

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Experiments on Indian Jute. Second Report.

its tensile strength (tested roughly by the hand on a few strands) exceptional. It was thought possible that the effect of the sulphite treatment would be to remove the more easily hydrolysable constituents of the fibre, and thereby to reduce the risk of fermentation setting up in the packed fibre. The results of examination of the treated samples tend to establish the contrary, as, judging from the numbers furnished by 6690 and 6689, which shows that the whole percentage loss under mild hydrolytic agents is somewhat diminished, as might be expected, the material has been rendered more sensitive to stronger reagents, and, therefore, that it had certainly not become less prone to change. A certain amount of colour had been developed in the fibre, and it was distinctly more tender. This result was communicated to Mr. Cross, the member of the Committee of Advice on Fibres, and he replied that some new experiments he and Mr. Bevan had made on cereal straws went far to explain the matter. They find that the proportion of permanent tissue or cellulose in the straws distinctly increases after harvesting, by merely keeping the fibre; that is, a hardening or oxidising action ensues. The treatment with the deoxidising salt appears to have the effect of preventing this oxidising action setting in, and is, therefore, not to be recommended.

The results of examination of the sample treated with sodium carbonate cannot be said to afford any evidence in favour of such treatment. The high percentage of ash in No. 5227 is easily accounted for by insufficient washing of the sample after removing from the saline solution. The difference between the A and B hydrolysis numbers shows some increase upon the difference in the untreated sample (5226), but comparison is rendered difficult by the fact that this latter appears to have suffered in some special way, judging from the unfavourable opinion of the experts.

The results of experiment III are rendered almost valueless by the fact that there was no special sample of the untreated fibre kept for comparison. The collector of the sample may have intended No. 5226 to serve this purpose, but the intention is not obvious in his notes, and, as before stated, No. 5226 has to be regarded with suspicion. Referring to the Report submitted on the 21st February 1895 (F. S. 41) upon a miscellaneous series of jutes contained in the Indian collections, it appears that the average difference between

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Experiments on Indian Jute. Second Report.

the A ahd B hydrolysis numbers is about 4. This difference is slightly lowered in samples 5232—5236 (treated with the alkaline ashes), but no very clear deductions present themselves in the analyses.

In view of the great difficulty of introducing any alteration of the usual method of preparing jute fibre, and of the doubtful evidence afforded by these experiments that any benefit results from the particular method of treatment tried, it cannot be urged that any more extensive trials in the direction indicated in these exp°riments should be adopted; the logical conclusion is that attempts at special chemical treatment of the fibre to be applied in India before supply to the jute mills, or before shipment, is not to be advocated.

The second Report on Jute given above received acknowledgment to the I. I. as under:—

From George Watt, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, Calcutta, to* Sir F. A. Abel, Bart., K.C.B., *Secretary and Director, Imperial Institute, London,—No. 1796—69 F. S., dated the 15th June 1896.*

With reference to your letter No. 301—70 (F. S. S. No. 85), dated 15th April 1896, and your letter No. 427—70, dated 24th April 1896, forwarding copy of a Second Report on Jute, I have the honour to state that this subject is still occupying attention. Additional samples are at present being despatched, and a further reply may be expected. Meantime I take this opportunity to say that the Reports already supplied seem of sufficient interest for publication and I am having them printed in *The Agricultural Ledger.*

G. I. C. P. O.—No. 488 R.&A.—21-12-96—2,100—A. McL.

(*Vegetable Product Series, No. 30.*)
(*Medicinal Products.*)

THE

AGRICULTURAL LEDGER.

1896—No. 38.

CINNAMOMUM TAMALA.

(TEJ-PAT. THE LEAVES.)

[*Dictionary of Economic Products, Vol. II.*, C. 1183.]

CINNAMON LEAVES.

A brief Description of the History of Tej-pat and its Use in Medicine. *By* THE ACTING EDITOR.

The Director of the Department of Land Records and Agriculture in Assam on the 22nd April 1895 forwarded some specimens of Tej-pat leaves for identification. In the letter accompanying the sample it was said that the tree yielding the leaves was largely grown in the Jaintia district for the sake of the leaves which were used as a condiment. The leaves belonged to **Cinnamomum Tamala,** and on their being referred to **Dr. Prain** of the Royal Botanic Garden, Sibpur, he pronounced them to be those of the variety **intermedium.**

The use of Cinnamon leaves in India has been known for centuries. At one time, as **Folia Malabathri** or **Folia Indi,** the leaves of certain Indian species of **Cinnamomum** were employed in European medicine, but now they have become obsolete.

The information we possess on the subject of Tej-pat as recorded in works on materia medica is very fragmentary, but the discovery of a large trade in this drug in Assam has enabled us to bring together all the recent facts in connection with the industry. On the receipt of the letter from the Director, Land Records and

CINNAMOMUM Tamala.

Cinnamon Leaves.

TEJ-PAT.

Agriculture, Assam, a set of questions was drawn up by the Reporter enquiring into the extent of the cultivation and commerce of the leaves. The replies to these questions sent in by the Director and other officials in Assam have assisted very materially in the compilation of a fairly complete *Agricultural Ledger* on the subject.

Botanical Origin.—Tej-pat is obtained principally from **Cinnamomum Tamala,** *Fr. Nees,* and its variety **intermedium.** The leaves under this name have also been derived from **C. albiflorum,** *Nees* (in the Lahore bazars), **C. obtusifolium,** *Nees,* and **C. impressinervium,** *Meissn* (in Sikkim), and the wild species **C. zeylanicum,** *Breyn.* The Tej-pat from wild trees found in Mysore and referred to in the *Pharmacographia* would probably belong to the last named plant. Roxburgh alludes in his *Flora Indica* to Tej-pat leaves as those of **Laurus Cassia,** a name which is now synonymous with **C. Tamala.** It has been stated by some writers that the leaves of any species of cinnamon are indiscriminately referred to as Tej-pat by the Natives.

Vernacular.—The drug is called *Tamáli* in the *Raja Nirghanta* and this is probably the origin of the specific name of the plant. *Tej-pat,* or, as it is also written, *Tidj-pat* and *Tes-pat,* is derived from *Tvach* or *Twacha,* the Sanskrit equivalent for cinnamon bark, and *pat,* the leaf. *Dálchini* (Chinese bark) and *Taj* are Hindu names applied to any kind of cinnamon bark. The *Taleef Shereef* gives *Tudje* and *Putrudj* as other vernacular names. The leaves are the *Sasaj-i-Hindi* of Indian Mahommedans. In Kashmir the leaves are called *Barg-i-Taj,* and in South India *Tamal patra* and *Talisha-pattiri.* From Assam we are informed that the cinnamon tree is called *Dieng Latyrpat* and the leaves *Latyrpat.*

Habitat.—**Cinnamomum Tamala** is wild in tropical and sub-tropical Himálaya, from near the Indus to Bhutan, at altitudes of 3,000-5,000 feet, ascending to 7,800 feet in Sikkim, and in Sylhet and the Khasia mountains to 3,000-4,000 feet. Gamble says it grows in the valleys of the Mahanadi and Tista, but it is not found much on the West of the Mahanadi. The tree is cultivated in Assam.

Cultivation.—In the Khasi and Jaintia Hills about six square miles are planted with **Cinnamomum Tamala.** Owing to the trees being grown amongst jack, betel-nut palms, and other fruit trees, the exact amount cannot be ascertained, but it is calculated that 400 acres are planted up in the Jaintia *parganas* and a small quantity in the submontane tracts, such as the Cherrapunji Hills in the north of the Sylhet district. The trees delight in a heavy rainfall.

TEJ-PAT.

Continuous rain is said to be unfavourable for their cultivation, but heavy rainfall followed by bright sunshine is most congenial. Storms effect considerable damage by breaking off the leafy branches. It is also conjectured that excessive moisture diminishes the odour of the leaves. In the Khasi and Jaintia Hills the trees are grown in regular plantations 7 feet apart; the seedlings are raised in beds, and planted out permanently when the plants are five years of age. The tree takes five or six years to grow, or comes into bear'ng at ten years, and continues to bear for one hundred years. The cultivation is in the hands of the hillmen.

In Sylhet the trees are self-sown; the ripe seeds fall from the trees into the soil and germinate. When the plants are about a foot high they are transplanted. Great care is bestowed upon the plants when they are young and tender. As constant exposure to the sun would kill the shoots they are planted behind bushes or trees for protection. The undergrowth is kept down twice a year in the plantations for the first eight or nine years of the plant's life, after that the jungle is cleared once a year in April. In some plantations the soil is dressed, but in most districts the soil is never manured or irrigated.

No reserve areas are kept for the growth of these trees. The Tej-pat and cinnamon trees are different. The former are only used for their leaves and no bark, or only a small quantity, is collected in the Khasi Hills. A small quantity is sent to Sylhet from Sibsagar and Lakhimpur by the Nagas.

Collection and Crop.—Tej-pat is plucked in dry and mild weather from October to December, and in some places the collecting is continued to the month of March. The leaves are taken once a year from young trees, and every other year from old and weak ones. On an average 15 seers may be obtained from one tree, but the quantity depends upon circumstances; a tree yields from 10 to 25 seers of leaves in a year. The average yield of leaf per acre in the Jaintia parganas is about 30 seers without, and 2 maunds with, twigs. The whole of crop from four hundred acres was worth last year as much as R1,100. The quantity of leaves from the Sylhet district last year calculated on the turn-over of the traders was estimated at 14,470 maunds, and from the Jaintia district 20,000 maunds.

In harvesting the Tej-pat the small branches are cut down with the leaves and dried in the sun for three or four days. The leafy branches are then tied up into convenient bundles ready for the market. In the other case, the leaves are separated from the branches and

CINNAMOMUM Tamala.

Cinnamon Leaves.

TEJ-PAT.

packed in bamboo nets of a cylindrical shape called *Bora* or *Jungra* which are four feet long by two feet in diameter. The packages are carried down the ghaut roads of the hills by coolies to Sylhet.

Disease.—The young trees are not usually attacked by insects, but the old ones are sometimes destroyed by white ants. The leaves are subject to a disease called *Guti* (small-pox). When attacked with this malady the leaves are spotted with black eruptions about one-eighth of an inch in diameter. Spots like these are often seen on mango leaves. Leaves injured in this manner are not plucked for sale.

Description of Tej-pat.—This is how Tej-pat is described in the *Taleef Shereef*. A very common leaf in length from 3 to 5 inches and in breadth 2 inches, of a green colour and pleasant smell; it is strongly marked by veins. It is brought from the hills. The author of *Makhzan* describes them as yellowish, coriaceous, ovate-lanceolate leaves with five nerves extending from base to apex, and says they are produced from a large tree growing in the mountains of Sylhet. The most careful description of Tej-pat is that of the *Pharmacographia Indica*. The leaves vary in size, the largest are 6 inches or more in length and 1½ inch broad, oblong, obtuse-pointed, entire, with three principal nerves and two smaller ones which are quite marginal; the venation between these nerves, which run from base to apex of the leaf is finely reticulated, and the leaves are of an olive-green colour; the upper surface is polished. They have a pleasant odour like a mixture of cloves and cinnamon.

Uses.—Tej-pat partakes of the aroma, pungency and probably carminative properties of cinnamon bark, and is largly used as a spice in various culinary operations. According to Dr. **Aitchison** the leaves are used in Kashmir as a substitute for betel-leaf or *pán* (**Piper Betle,** *Linn.*) and Dr. **Lisboa** speaks of their being employed in the preparation of curries in the Bombay Presidency. *Pán* and various curry leaves have to be used in a fresh condition on account of the fugitive nature of their aromatic principles, but Tej-pat possesses a distinct advantage over other leaves in retaining its volatile oil for a considerable time after being plucked and dried. As a matter of fact, cinnamon leaves in India take the place of the domestic flavouring agent in England known as Bay leaves (**Laurus nobilis**).

In the *Taleef Shereef* or Indian Materia Medica (translated by **Dr. George Playfair,** 1833) the medicinal properties of Tej-pat are described as being hot and light and cardiac, useful in wind, piles, nausea, pain in the stomach and flatulence. The author of the *Makhzan* considers the drug to be carminative, stimulant, diuretic,

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TEJ-PAT.

diaphoretic, lactagogue and deobstruent. In the *Raja Nirghanta* it is mentioned as a remedy for the expulsion of phlegmatic and rheumatic humours and is prescribed in cases of flatulence and dyspepsia. Besides being used directly in medicine, the leaves are employed as adjuncts to other drugs to render their exhibition less nauseous.

The third use is that of a dye. In the North-West Provinces Tej-pat is mixed with myrobolans and employed in calico printing and apparently acts as a clarifier. The bark and leaves of the Taj are used in Chutia Nagpur as an auxiliary with *Kamela* (**Mallotus philippinensis**) as a dye.

Chemical Composition.—Kurz in his "*Forest Flora of British Burma*" made a very suggestive statement, when, in describing **Cinnamomum zeylanicum**, he said, "The leaves yield oil of cloves." The cloves are obtained from quite a different plant (**Eugenia caryophyllata**, *Thun.*), but it is a remarkable fact that the prevailing constituent of the oil is identical with that found in cinnamon leaves. The oil of the leaf was first described by Kampfer in 1712. Dr. Stenhouse in 1854 found it to have a specific gravity of 1·053 and to consist of almost pure eugenol with a little terpene and cinnamic aldehyde. Professor E. Schmidt, Berlin, confirmed the result of this analysis in 1891, and further showed that the oil of cinnamon root contained eugenol and terpene, and the oil of the bark cinnamic aldehyde and terpene. The oils of cinnamon leaf and cloves are, therefore, remarkably similar in consisting of a large proportion of a chemical body known as eugenol or eugenic acid.

Commerce.—A small quantity of Tej-pat is consumed locally, but the bulk of it is exported to Narainganj, Dacca and other places in Bengal. The Khasias usually sell the leaves in Sylhet to Bengal merchants who send the leaves to a large extent to Calcutta. The price of the leaves is 8 to 10 annas per maund with branches, 14 annas with twigs, and R1-4 to R1-6 cleaned.

Tej-pat is largely imported from Nepal and the forests of the North-West Provinces. About 33 tons of leaves and 24 tons of bark are annually exported from the tract between the Ramaganga and Safda rivers of the Kumaun district. Gamble notices the collection and sale of the leaves in Sikkim.

The following table shows the return of the sales of Tej-pat from three districts in the North-West Provinces about twenty years ago :—

	1874-75.		1875-76.	
Bijnor . .	36¼ cwts.	R 62	18¾ cwts.	R 76
Garhwal . .	14¼ "	" 30	35 "	" 37
Kumaun . .	88¾ "	" 272	120½ "	" 374

C. 1183.

G. I. C. P. O.—No. 547 R. & A.—26- 12-96.—2,100.—B. N. D.

(Veterinary Series, No. 25.)

THE AGRICULTURAL LEDGER.

1896—No. 42.

ELEPHAS INDICUS.

(THE INDIAN ELEPHANT.)

[*Dictionary of Economic Products, Vol. III.,* E. 83-150.]

THE ELEPHANT IN BURMA.

Note by VETERINARY CAPTAIN G. H. EVANS, A.V.D., *Superintendent, Civil Veterinary Department, Burma. To which is prefixed extract from 'Voyage of* JOHN HUYGHEN VAN LINSCHOTEN *to the East Indies,' 1596.*

INTRODUCTORY.

INTRODUCTORY.

It is thought that Veterinary Captain Evans's Note on the Elephant in Burma may be suitably prefaced by the following particulars extracted from Linschoten's Voyage to the East Indies published in 1596.

When writing of Madagascar Linschoten says: "This iland hath Elephants and all kinds of beasts." Of their being eaten by the natives of Mossambique he says:—"Their chiefest living is by hunting, and by flesh of Elephants: which is the cause that so many Elephants' teeth are brought from thence." Further he says:—"Of the Elephants' teeth they make their weapons, instéede of Iron and Steele."

Of Aracan and Pegu he writes:—"There are greater number of Elephants in those countries, than in any other place of [India, or]

BURMESE ELEPHANTS.

the Orientall countries: and the Portnigalles that traffique there, affirme that the King of Pegu hath a white Elephant, which hee† prayeth unto, and holdeth it to bée holy."—(*Editor.*)

*THE ELEPHANT IN BURMA.**

The Elephant met with in Burma is the Asiatic species (**Elephas indicus**)—

Burmese, *Hsen*, wild elephant, *Tor-Hsen*; Shan, *Sant-Hain*, wild elephants, *Sant-Htaint*; Karen, *Ka-Sau*.

White elephant regarded as sacred.

From time immemorial the Burmese and Siamese have regarded the white elephant as a sacred beast. Sir John Bowring states that the reason why this animal is so specially reverenced is "because it is believed that Buddha, the divine emanation from the Deity, must necessarily in his multitudinous metamorphoses or transmissions through all existences, and through millions of æons, delight to abide for some time in that grand incarnation of purity which is

† "Hee," orig. "they." These sacred elephants are still kept by the Kings of Siam and Burmah. This superstition has not as yet been fully explained. It is probably to be traced to the notion of the Buddhists, that Buddha was six times incarnate as an elephant (Hardy, *Manual*, p. 100). These holy elephants are not, however, white; it is enough if they are marked with certain white spots. Mgr. Pallegoix (*Siam, I., p. 152*) says: "Mais comme . . . . les Buddhas . . . . serout nécessairement singes blancs, ... éléphans blancs, ils out des grands égards pour tous les animaux albinos et surtout pour l'éléphant, blanc. Ils croient qu'il est animé par quelque héros on grand roi qui deviendra un Jour Buddha, et qu'il porte bonheur au pays qui le posséde." Cf. also, II, p. 2, Ed. 1885.

...... "In winter when it beginneth to raine, then they are unquiet,[1] and altogether mad, so that their keepers cannot rule them, and then they are let some whether out of the towne to a great tree, and there tyed unto it by the legs with a great iron chaine, where they carry him meate, and so hee lieth in the open aire, as long as he is mad, which is from Aprill to September, all the winter time when it raineth, and then he commeth to him selfe, and beginneth to serve againe as tamely . . . . but he that hurteth him, hee must take heede, for they never forget when any man doth them iniurie, untill they be revenged. Their teeth which is the ivory bone, is much used in India, specially in Cambaia, whereof they make many curious peeces of workemanship, the women weare manillas, or arme bracelets thereof, ten or twelve about each arme, whereby it is there much worne,[2] and are in great numbers brought out of Aethiopia, Mosambique and other places"—*Voyage of John Huyghen van Linschoten to the East Indies; Dutch edition dated 1596, with notes by Paludanus (copied in red ink): 1st English edition 1598: present edition by Burnell Tiele and Yule, dated 1885, Vol. I. pages 21, 30, 274, 98; Vol. III, page 215.*

[1] Orig. Dutch: "tochtig" (ruttish).
[2] Orig. Dutch: "bought." Ed. 1883.

* Reprinted from the *Englishman*, 10th September 1896.—*Ed.*

BURMESE ELEPHANTS

represented by the white elephant. While the Phongyis (priests) teach that there is no spot in the heavens above or the earth below or the waters under the earth, which is not visited in the peregrinations of the divinity, whose every stage or step is towards purification, they hold that his tarrying may be longer in the white elephant than in any other abode, and that in the possession of the sacred creature they may possess the presence of Buddha himself."* The same author states that these animals have been the cause of many a war, and their possession more an object of envy than the conquest of territory.

The kings of Burma were very proud of the titles of "Lord of the Celestial Elephant," and "Lord of many White Elephants." The kings of Siam also glory in these pompous titles; in that country everything associated with majesty and rank bears the image of the white elephant. These animals are surrounded with all the adjuncts of royalty, *viz.*—gold umbrellas, etc.,—and when they die are accorded a royal funeral.

The Burmese being Buddhists are naturally kind to all dumb creatures, so that the elephant, in common with other domestic animals, is well cared for.

Wild Elephants.—These animals are very numerous and roam about in large herds in the dense jungles at the foot of the hills; very few are caught and tamed by Government for the use of the State. The kings of Burma used to carry on "kheddah" operations on a small scale, in the Mandalay and other districts, and were, I believe, fairly successful. I feel certain that if operations were properly conducted, large captures could be made;—the animals are plentiful enough.

Elephant-catching formerly practised.

As a general rule the herds vary in number from five to sixty animals, but the latter figure may often be exceeded. The animals met with are compact, massive and of fair height; with regard to the latter point there may be slight variations between Indian, Burmese and Siamese animals. The usual pace of elephants is a walk; it is only when annoyed or scared that they take on a faster rate of locomotion which is a shuffling amble, but the wonderful amount of speed these creatures can attain in an incredibly short time is only known to those who have had an enraged monster after them. The elephant is no doubt "King of the Forest;" they are rarely interfered with by other wild beasts: now and again, however, a hungry tiger

Herds.

Description.

* Sir Monier Monier Williams, K.C.I.E., says the elephant is perhaps the most sacred of all animals.—*Buddhism*, pp. 23, 24, 84, 325.

ELEPHAS indicus.

The Elephant in Burma.

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may attack a solitary animal. A year or two ago, in the Tharrawaddy district, a tiger attacked, on different occasions, one or more animals, the property of a Burman contractor, inflicting such severe injuries that, I believe, one or more succumbed. It is calves that usually fall victims to tigers, and the manner in which they catch them is as follows:—A tiger having observed calves in a herd lies in ambush close by awaiting an opportunity (which usually occurs while the herd is busily engaged feeding), and then springs out, seizes a calf by the leg, just above the pad, and bolts. The herd after his attack is on the *qui vive*, so he keeps out of the way, but while they are moving off to fresh ground the tiger follows; the little one being lame probably lags behind, thus giving stripes another chance. If he does not get one he waits till the herd settles down again to feed, and then when the opportunity offers he makes another dash at his victim and invariably bites a second limb. The calf is now *hors de combat*, and the tiger knows that he has only to wait, since the herd, if large, cannot stay long in one place; twenty or thirty animals will soon clear all the "tit bits" on the ground where they are feeding, or they may want water, so the young one has to be left behind. I believe, however, that they will not abandon a calf until they are forced. As soon as the herd is clear, the tiger finds a young beast an easy prey, and no doubt a very excellent meal. In January last a tiger attacked a calf in a cane-brake. The little fellow was crying pitifully; his legs were so badly bitten that he was really unable to walk a few yards, so had to be shot. Two cows were on guard, and charged so furiously that they also had to be killed. All this occurred within fifty yards of a main track through the jungle. The people sometimes catch a "rogue" or other destructive beast by means of pitfalls. These are made in the following manner: The point selected for digging a pit is on one of their well-known tracks to certain water or cultivation, and usually at a spot where the grass or jungle is very thick. The pit having been dug, all traces of fresh earth are removed; the mouth is then carefully concealed with bamboos, elephant-grass, etc. After this a good amount of fresh droppings is procured, and these are thrown over the grass. This *ruse* tends to throw an animal off his guard, and so he falls into the trap. The men then turn out and destroy the animal with spears or a gun. Karens now and again capture one or two with the aid of tame elephants. Considering their great size, elephants are wonderfully active—climb up and go down steep places in a surprising manner; and they are also excellent swimmers. When in deep water, the

Elephant calves liable to attack by tigers.

Manner of attack.

Trapping obnoxious animals.

Activity of elephants.

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whole body is immersed: only the end of the trunk is kept above water.

Value of Elephants.—In a country like Burma the great value of these creatures can readily be appreciated, large areas being covered with dense impenetrable jungle, immense marshy tracts, steep hills and deep ravines; added to which the whole country is intersected by rivers, large and small. In the absence of waterway in a place such as described, elephants are more than useful, they are indispensable, they can with ease penetrate the dense and pathless jungle, their great size and weight causes them to leave a very fair track as they move along; they can cross wide rivers, ford fast-running streams, carry men and baggage across swamps and heavy marshes penetrable to no other kind of transport animal. The value of an animal for transport purposes possessed of such strength and docility cannot be over-estimated. Immense utility of elephant in Burma.

In Burma, elephants are largely employed in the timber trade; in fact the great commerce carried on in this line may be said to depend almost entirely on elephant-labour. The timbers being scattered over wide areas of country without roads or slips, the logs have to be dragged by elephants through the jungle, over ridges, down ravines, and finally pushed into the floating streams, when, owing to the immense strength of these animals, they can stand in the strong current and sort the timber for rafting, clear it when the logs get jammed, and push them back into the water when stranded. In the large timber yards in Rangoon, Maulmain, etc., they have to haul the logs out of the river, bring them up to the sawbench; and after they are shaped, the elephants remove and stack them as neatly as if done by human hands, and in all these operations they are cheap and most efficient. It is quite one of the sights in Burma to see the timber-yard animals at work. Elephants and timber trade.

Powers of Endurance.—Though such enormous creatures, they are constitutionally delicate. I fear that, through lack of appreciation of this fact, these animals have not received the amount of attention they justly deserve; and owing to the popular opinion that they are very strong, they have been too highly tasked. A great deal of the ill-health and mortality amongst elephants may well be ascribed to this cause. It cannot be too forcibly impressed on those persons entrusted with the care of public animals that untiring and vigilant superintendence over the attendants is the means, above all others, for the proper preservation of the efficiency of the animals committed to their charge. They must remember that the class of men usually employed with transport, if left to themselves, are, from Elephants require careful attention.

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general indolence, carelessness, or from a desire to avoid the fatigue and hardships of a campaign, quite liable to render their animals unserviceable. Ample supervision enables the carrying out of systematic checks against carelessness, and, still more, of checks to malpractices. A little neglect will often deprive a force of the valuable services of many animals.

Purchasing.—To begin with, it will perhaps be as well to mention the points of a healthy elephant.

The healthy elephant described.

The animal is in constant motion, with the ears flapping, and the tail and trunk swinging to and fro. The skin is almost black and the bristles covering the body are firm to the touch; the light-coloured spots on the head and trunk are of a pinkish colour; the eye is bright and clear, pulse from 48 to 50 per minute; mucous membranes of mouth, etc., are of a beautiful pink colour; the back is free from scars; a moist secretion exudes around and above the nails, and is easily seen by throwing a little dust on the parts; the pads are hard, and free from tenderness; any signs of the latter may readily be detected, as the tender patches are smooth and of a yellowish-pink colour. If the appetite is good, the animal sleeps for a few hours every night, and on waking commences to feed.

How to detect ill-health in the elephant.

The signs of ill-health are general languor, the skin looks greyish in colour, as also do the spots on the head and trunk; the mucous membranes are pale or deep red, with or without dark blotches on the palate; pulse is abnormal, appetite is lost; the animal does not take proper rest; eyes are dull, and there is frequently a copious flow of tears; there is usually fever, and the animal may be out of condition. As with other things, when buying elephants the purchaser should not be in a hurry, as his bargains may not afterwards prove to be all he desired. A little time should be taken to ascertain the idiosyncrasies of the beast about to be bought. The manner in which the keeper goes about his charge should be noted. Some animals are very full of tricks, and, if not approached to their liking, may attack a new keeper, or if timid be scared for ever. The animal should be marched about, and the pads carefully inspected after exercise; it is a common thing to fill up holes in the pads with stopping.

Elephants of peculiar habits avoided by Burmans.

Burmans look upon elephants with certain habits with superstitious dread; such creatures may be bought at very moderate figures. An elephant showing a peculiar general restlessness of the body somewhat after the manner of a bear, is much dreaded, as also is a creature that has the habit of swinging his trunk only to the right and left.

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The height of elephants is measured in cubits. The cubit is about twenty inches.

Signs of advanced age.

With regard to age, the appearance of an old animal is as follows:—The head is lean, deep hollows are present over the eyes, there is frequently a certain amount of opacity around the margin of the corneæ (Arcus senilis), and an abnormal flow of tears. The edges of the ears are torn and frayed; the skin of the trunk is rough, something like shark skin; the trunk itself seems to have lost a certain amount of its suppleness; the skin over the body is much shrivelled; the tail is hard, and the end may be devoid of hair; the skin around the nails presents a rough or warty appearance; the legs are thinner than they ought to be. Other indications of age are, the general appearance, and an awkward mode of progression, etc. A rough guess at the age may be made by observing the condition of the ears, the upper edges of which lap over to the extent of an inch at the age of thirty, which increases to two inches between this age and sixty years. The teeth also afford some information as to probable age; it is, however, most difficult to determine with any degree of certainty the age of these animals.

"Elephant-lifting."

In Burma notes must be taken of every mark of identification, as "elephant-lifting" about the frontier is a popular and very remunerative industry. In the jungles, after the day's work is finished, the Burmese foresters generally put cane fetters on their animals, suspend a bell or wooden clapper from their necks, and then turn them loose to graze; they do not keep any watch over them during the night. The thief who has been lying close by, waits till an animal strays a bit, creeps up to him, cuts through the cane hobbles, and, after driving him a short distance, jumps on his back, and takes him the shortest cut into Siam. The hills clad with very dense jungle afford such gentlemen ample shelter; the owner, as a rule, has the good sense not to "hunt for a needle in a bundle of straw."

Severe measures required.

Accomplished thieves make plenty of money, for they steal an animal in our territory, sell him in Siam, steal him again a month or so after, bring him across our frontier, and once more dispose of him to some one at a place many miles distant from where they originally stole the beast. I once heard a man remark that if he had anything to do with the framing of law he would put "elephant-lifting" under crimes punishable with death. Needless to add that he had lost more than one animal in this unsatisfactory way; by great good luck he recovered one, after spending a few hundred rupees. Distinctive marks are, as a rule, not very numerous on these creatures.

Burmese elephants may be divided into two classes, *viz.*,—

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A.—Timber elephants. These may again be put into two divisions, *viz.*:—

(1) Trained tuskers.

(2) Trained males and females.

B.—Baggage elephants.

Prices of trained elephants.

A well-trained tusker always commands a high price in the market; he is much more useful than a tuskless animal, as with the aid of his tusks he can stack timber, carry blocks on his tusks, turn logs over, and help in getting them over obstacles. Prices run from R1,100 to R3,000, according to size, training, and the length and thickness of the ivory. Merchants are always ready to buy, and are prepared to pay fancy prices. These animals are mostly employed in the yards. Dragging elephants: these are mostly tuskless males and females, are trained to the jungle-timber trade, which is very hard work; they have to drag the logs up hill and down dale, through thick cover, till they get to a stream. Well-trained ones sell for a good figure—anything from R1,100 to R1,800. Most Burmese animals are trained to this work. Tuskers are also employed in jungle work. The baggage animals are often Siamese elephants. The demand is small, and they may be bought fairly cheap—R800 to R1,200—which, after all, is only what one has to pay for a respectable horse.

Tame animals are plentiful enough; I know of one company that have at least 600 elephants at their command. The firms engaged in this industry own large numbers of elephants, but they also have a number of Burman, Karen and Shan contractors in their employ, who undertake to work out a certain amount of timber at specific rates, employing their own animals. Some of these men own many animals.

Elephants largely obtained from Siam.

Siam is the country in which to purchase these beasts, as they are cheap and are more accustomed to baggage work. Some of the firms buy many of their animals over there. The usual way the merchants get at them is by sending messengers to say that animals are required, and that they will be ready to inspect any animals brought into certain places on our frontier, on stated dates. Dagwin, on the Salween, would be a good place to get at the Laos elephants, as the grounds are distant only about three days' march. Papun, in the Salween Hill Tracts, would also make a good base. I believe the average price is R800. Muang-nan (Lat. 18° 50′ N., Long. 100° 45′ E.) is considered by Burmans to be an excellent place to buy elephants. The price is said to be from R500 to R1,000. Rahaing (Lat. 18° 50′ N., Long. 99° 900′ E.) on the left bank of the

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Me-Ping is also considered to be a good centre: a very extensive trade in teak is carried on in the Rahaing district and elephants are plentiful. The town itself is distant about seventy miles from Myewaddi, one of our frontier posts in the Maulmain district. Animals could be marched in with ease. Moung-Hpay is another place in Siam. Some animals might also be bought at Kyank-Kyoung, which is not very far from our frontier in the Tavoy district.

The Siamese around Chengmai (Zimme), Kyon-Taing, and Mohauk are said to breed elephants. The truth is they own a large number of animals which roam about the jungles in a semi-wild state, and, as might be expected, a certain number of calves are born These people also buy up all the calves they can lay hands on and let them go about till they can sell or train them. Calves may be bought for little or nothing; this is also the case in Burma. Owners would often prefer to give them away rather than be subjected to the expense of keeping them. A great many animals may be found in most of our frontier districts like Tavoy, Amherst, Shwegyin, Toungoo, Salween Hill Tracts, and in Karenni. I believe there are from 200 to 300 in the latter place and about 100 in and around Papun. In certain parts there is hardly a jungle village that cannot boast of possessing an elephant, and the usual rates for hire of a baggage animal is R2 per diem.

Value of Elephants as Transport in Burma and Adjacent Countries.

My experience of elephants as transport animals is that they are very good; provided the animals receive proper care and supervision they do not, as a rule, suffer much from disease, and are capable of performing a great amount of work. The majority of cases of elephants being disabled by sore-backs and feet are, in my opinion, due to want of supervision. If every care be taken to see that animals receive their food, are not over-loaded, saved unnecessary labour, and that parts exposed to irritation be regularly inspected before and after work, I am certain that the persons in charge will be well repaid for their trouble. The advantages of these animals for transport are—

Suitability of elephants for transport.

1. They can be fairly easily obtained, hire or purchase; can be quickly and easily loaded; require no rations to be carried, fodder being in most places plentiful. Most of the animals in the country are trained to jungle work and are used to roughing it.

2. They march at a fairly good rate, and in heavy country could keep up with troops or would not be left very far behind. If moderately

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loaded, they would do well for a forced march, as they keep up an average pace, and can do without sleep for a fair time.

3. They do not occupy much space on the line of march, so are economical as regards escorts. Owing to their immense strength they can do all manner of odd jobs.

4. They require no more care or supervision than is necessary for other kinds of transport animals. (They seldom get it, however, being, as a rule, left to the mercy of the native attendants.)

5. The base of operations and along the line of communication are the best places to employ them, as they are less exposed to attack or capture, and can be more easily fed.

6. The physical condition of the country, the denseness of the forests which clothe so large a portion of it, the forest-clad hills, large rivers, swamps, utter want of roads—all point in favour of the elephant being the animal to surmount such difficulties.

Objections.—One great objection to the use of elephants is that they will not stand fire; they are very easily alarmed; small animals such as terriers often cause them to bolt.

2 They can be seen some way off, and their immense carcases afford fine targets for an enemy.

3. Should these animals be employed on service from this country, I would recommend that commissariat guddees and gudelahs be provided. The iron saddle is not necessary, I think, for jungle work elephants are much better without them. One Indian attendant for each animal would be necessary to do the loading. If Chinese (Panthè) mule transport and Shan pack-bullocks were also engaged, the Burmese elephant gear would answer.

G. I. C. P. O.—No. 437 R. & A. D.—14-4-97—A. McL.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

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